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SCIENTIFIC AMERICAN

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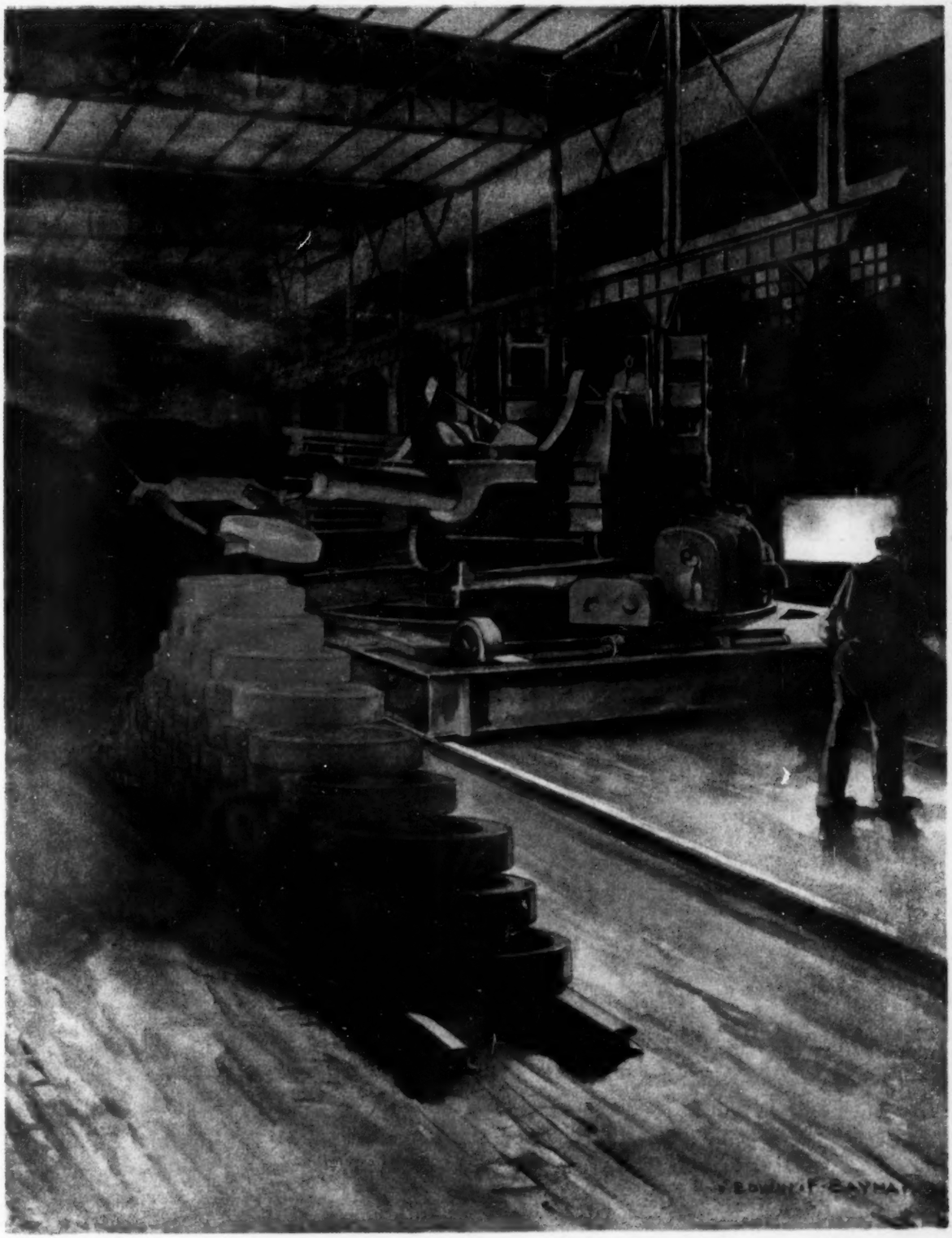

AN ELECTRICALLY OPERATED MACHINE FOR STACKING FINISHED WHEELS [See page 650]

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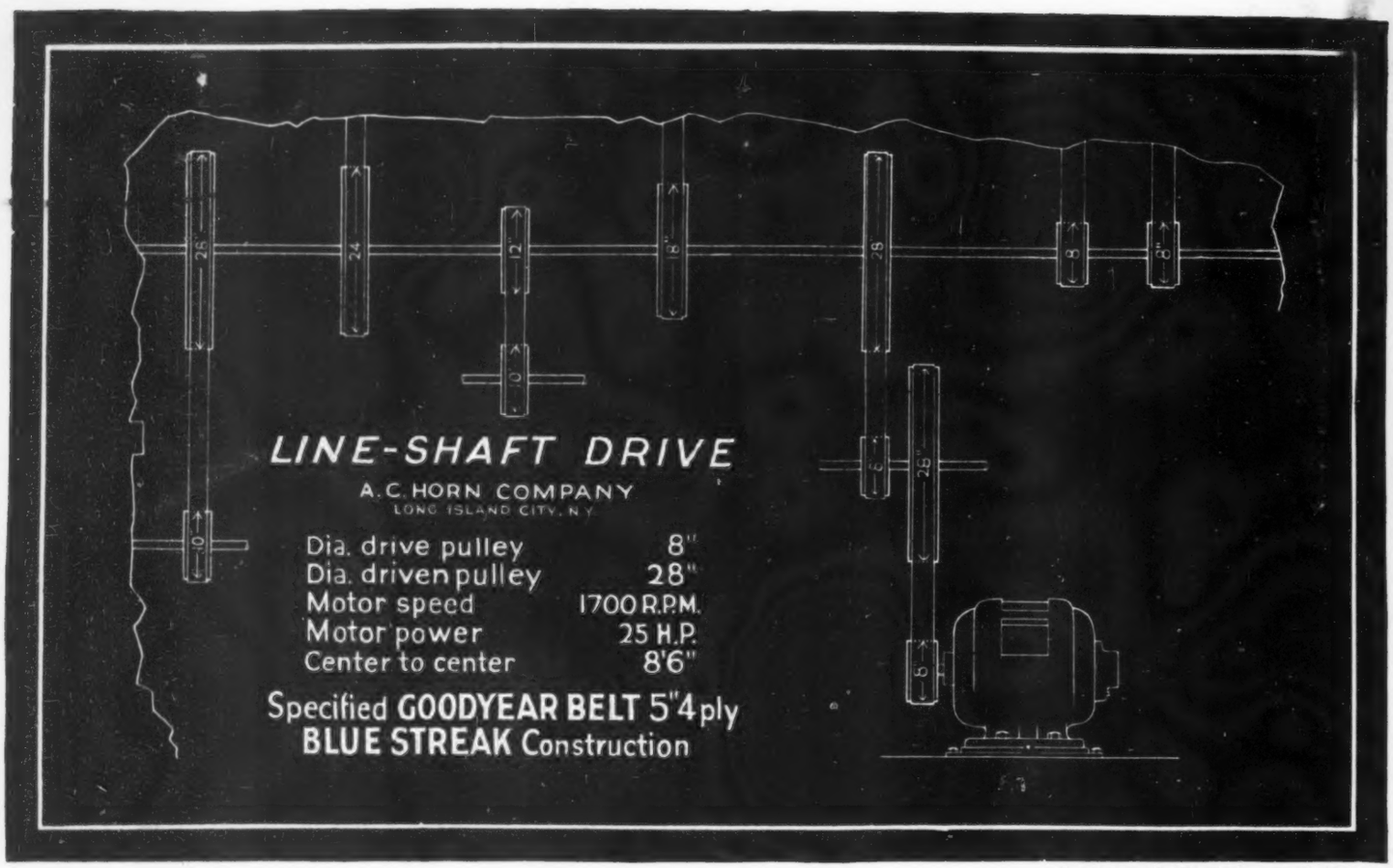


Copyright 1919 by The Goodyear Tire & Rubber Co.

That Line-Shaft Drive, an Advertisement—and the G. T. M.

The A. C. Horn Company, Long Island City, N. Y., used to have much trouble with one of their line-shaft drives. On it even the most expensive double belts wore out in six months. Before they wore out they often slipped off the pulleys, or broke, leaving idle all the labor and machines depending on that line-shaft for power. The drive was costing a lot of money for belts and belt repairs, and more in lost production. One day Mr. Horn saw an advertisement telling about what a G. T. M., Goodyear Technical Man, had done in solving a difficult belting problem—reducing costs and increasing production.

He sent for a G. T. M. Our Mr. Miller came, studied the drive, measured pulleys, horsepower, speed and the like. He noted that the air was exceedingly dry and that there was a great amount of lime dust—which accounted in part for the rotting and wear of the belts previously used. So he specified a Goodyear Belt of Blue Streak Construction—designed to operate under just such conditions—and an inch narrower than those formerly used.

The price was much less than Mr. Horn had expected—so much less that there was some doubt as to whether a belt of such modest price could meet the exacting conditions. But one was ordered and installed.

That 5-inch 4-ply Blue Streak has already given half again as much service as the most expensive belt they had ever used. Still more important, it has done away with the delays and diminished production that used to be so common. And it looks good for many more months of trouble-free service

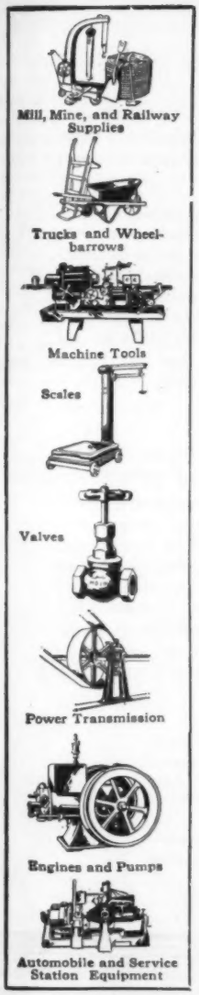
After that the G. T. M. made a plant analysis—analyzing every drive in the plant and prescribing the proper belt for it. Five of the recommended belts have already been installed. Every one of them has proved to be a strong endorsement for the value of the G. T. M.'s service.

If you have a difficult drive that either devours too many belts or interrupts production too often—or both—ask a G. T. M. to call. He'll do it without charge when next he is in your vicinity. There are many of them—all trained in the Goodyear Technical School—all with experience in plants similar to yours—all trained to sell belts to meet conditions and not as a grocer sells sugar.

THE GOODYEAR TIRE & RUBBER COMPANY, AKRON, OHIO

GOODYEAR

AKRON



WHICH WAY?

A Short Cut for Purchasing Departments

Case 1. The purchasing Agent of a big company looked over his needs. In all, he wanted 13 distinct items. He sent out 13 separate orders to 13 different companies.

Note what happened: He received 13 acknowledgments. He followed up 13 companies for prompt deliveries. His Receiving Department reported 13 arrivals, checked 13 Bills of Lading and 13 invoices. The cashier made out 13 individual checks, to say nothing of the 13 envelopes the stenographer addressed and the 13 stamps.

13+13+13+13+13+13+13+13—Look at the cost in time and motion!

Case 2. Here is what is happening more and more in busy Purchasing Departments. Suppose 13 distinct items are wanted. It is frequently found that The Fairbanks Company can supply all these needs. One order is sent.

One acknowledgment is received. Generally the delivery is made in one complete shipment. One bill comes in. One entry is made on your books. One check is drawn.

Note the time and motion saved!

* * *

PURCHASING direct from The Fairbanks Company saves doubt as well as motion, "The Fairbanks Company O.K." is put on all articles sold by the Company. This O.K. means that the articles have been passed by The Fairbanks Company as O.K. in quality, O.K. in design, and O.K. in price.

"The Fairbanks Company O.K." is put on Mill, Mine and Railway Supplies, Valves, Engines and Pumps, Scales, Machine Tools, Power Transmission, and Trucks, and Wheelbarrows, and Automobile and Service Station Equipment. It is backed by quality and service which have given The Fairbanks Company an international standing.

The more value you place on your time the quicker you will want to get in touch with the nearest Fairbanks Branch House.

THE
FAIRBANKS
COMPANY

Administrative Offices:
NEW YORK

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Albany	New York
Baltimore	Paterson
Boston	Philadelphia
Birmingham	Providence
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Buffalo	Rochester
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The FAIRBANKS *Company*

MILL MINE & RAILWAY SUPPLIES SCALES VALVES POWER TRANSMISSION
MACHINE TOOLS TRUCKS & WHEELBARROWS ENGINES & PUMPS AUTOMOBILE AND SERVICE STATION EQUIPMENT

"What *is* packing anyhow?"

Our salesmen frequently comment on how often their friends, outside the business, ask the question—"What is Packing?"

Some of the ideas as to the meaning of the word are very amusing in their vagueness and it is very seldom that the average man realizes just what a big part this product plays in the efficiency and economy of the industrial machinery that is making the world better for us all.

So for all its seeming insignificance the story of what packing is would seem to be well worth telling and well worth reading by anyone.

* * *

AS a starter, consider Packing as something like the "washer" in your kitchen faucet. It prevents leakage—or ought to.

Now whenever steam is put to work—or water, gas, brine, or ammonia—packing is needed. It is needed to prevent leakage where gleaming rods slide smoothly in and out of cylinders, for leakage here means not only loss of steam or water, but actual waste of power.

And inside the cylinders of pumps, packing again saves power. With perhaps two hundred pounds pressure on one side of the piston, and a vacuum on the other, piston packing prevents leakage past the piston.

And sheet packing, cut or molded into gaskets, prevents leakage at joints of surfaces or piping.

So, fundamentally, packing guards against leakage.

But when it works against moving surfaces, packing is subject to wear—or it goes "dead," and loses its elasticity. This means replacement, shut down machinery and expense. So the buyer of packing must ask not only "Will it prevent leakage," but also "How long will it last"—which of course depends on the material and workmanship put into it.

And there's a third question, which the engineer will ask if you don't, "How much friction does it cause?" For some packings prevent leakage merely by filling up the packing space as solidly as possible. Naturally such packing binds the moving rod—sometimes even scores it—and acts more or less as a brake. It is such serious faults as this that Johns-Manville has overcome through intelligent packing designs.

So packing is not a thing to be bought at random—the right choice will save money by preventing leakage, by conserving power, and by its longer life.

As the pioneers in packing development we have placed packing design on a scientific basis, and out of experience, observation and facts have established a complete and standardized line that meets every plant requirement from among the minimum number of packings. Only in this way can packing be made to give a maximum of service for a minimum of cost.

Here is a partial list of Johns-Manville Packings: Sea Rings for outside packed Rods; Service Sheet, an all-around-the-plant sheet packing; Universal Piston for inside packed pumps; Kearsarge boiler, man and handhole gaskets; Mogul Coil Packing for valve stems and small rods; Siegelite Sheet for packing oils, gasoline and naphtha.

H. W. JOHNS-MANVILLE CO., *New York City.* 10 Factories—Branches in 63 Large Cities

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

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and its allied products

INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
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that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Serves in Conservation

SEVENTY-FIFTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXX.
NUMBER 25

NEW YORK, JUNE 21, 1919

10 CENTS A COPY
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Monetary Cost of the War

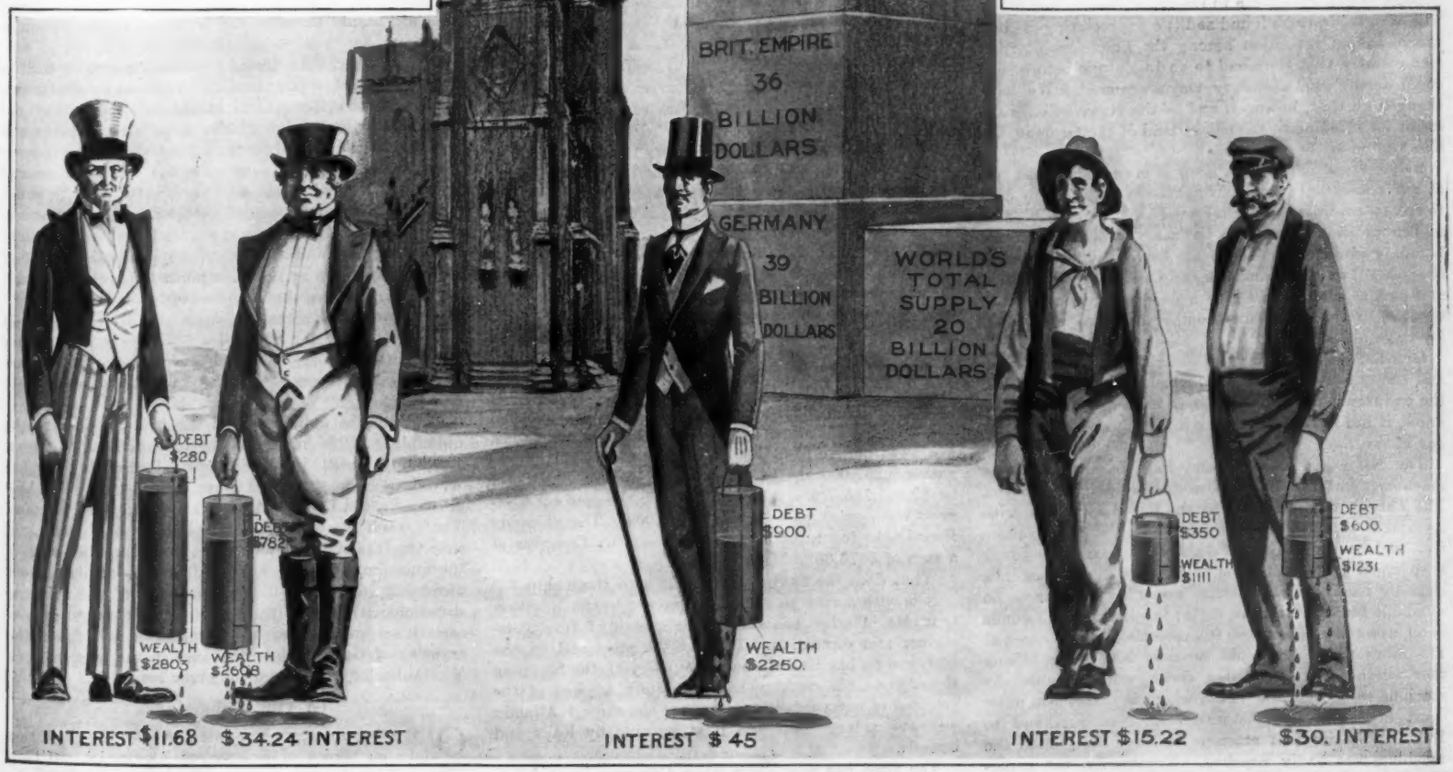
IF all the gold in the whole world were melted up into bullion and minted into double eagles it would not cover more than two-thirds of the debt incurred by the United States in the great war we have just passed through; and yet two of our Allies have each incurred a heavier debt than we did in prosecuting the war. It is difficult to form any conception of the enormous cost of the war, but we have endeavored to give some idea of it by a graphic comparison of the debts of the four great allied powers and that of Germany. It used to be that a million was spoken of very glibly and statisticians bewailed the fact that the general public had no idea of the meaning of that word. Now we think of a million as a mere trifle and talk as glibly about billions.

It is impossible and at the same time unnecessary for us to conceive of the vast number of dollars represented by our war debt. We cannot visualize a billion dollars in terms of dollars because the unit is so small, but we can gain some idea of the quantity, when we adopt a larger unit of measure. For instance, if corn were sold by the kernel we should have to talk of millions and billions of kernels to represent a small quantity of corn. Instead of that we adopt a larger unit of measure, namely, the bushel, and so in dealing with war debts of the nations instead of trying to represent the vast sums of money in units of the size of a gold dollar we can conceive of the amount involved if we adopt a cubic foot as the standard. Therefore, in the accompanying comparison we have illustrated the debts in solid cubes of gold, measurable in cubic feet.

Our figures are based on statistics prepared by Harvey E. Fisk in his book entitled "Our Public Debt" which was recently published by the Bankers' Trust Company. The statistics were compiled prior to the 15th of April, but we have added the amount of the Victory Loan so that our figures differ somewhat from those given by Mr. Harvey E. Fisk. The debt of the United States before we entered the war was approximately one billion dollars. Now it is approximately 30 billion dollars. To be sure, this includes about 8.5 billion dollars of interest bearing obligations of foreign governments and contemplated loans of about 1.5 billion, making 10 billion altogether, which eventually will be repaid. Comparing this with previous wars in which we have engaged we find that it dwarfs all other figures. This country was born with a debt of 76 million dollars incurred in fighting the Revolutionary War. At the close of the War of 1812 our debt was 127 million dollars; the Mexican War, including the Texas Indemnity put us 68 million dollars in debt; while the Civil War saddled us with a debt of $2,844,649,616.

If we should take 30 billion dollars' worth of gold and form it into a single cube we should find that it contained 119,280 cubic feet and that the cube measured 44.2 feet

(Continued on page 667)



War debts of the principal nations involved in the war represented as a golden tower, compared with Trinity Church Steeple, New York; also the per capita wealth, debt and interest on debt

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Always On Its Toes

NOT infrequently, in recording the progress and achievements of the Navy, we have noted the fact that the Navy is always on its toes. Notably was this the case in the matter of transatlantic flight. No sooner was the armistice signed and the pressure of war service removed, than our Naval Air Service bent itself with redoubled energy to the task of proving that a seaplane could be built that would fly the Atlantic.

That air-voyage from Long Island to Plymouth by way of Newfoundland, the Azores and Lisbon, will take high rank in the annals of naval achievement, and to the Navy will the nation be forever indebted for the distinction which has come with the construction of NC-4 and the skillful pilotage of Commander Read.

It was fitting that this distinction should go to the country which gave birth to the art of mechanical flight. The Wright brothers found so little appreciation of their epoch-making invention among the financiers of their own country that they had to go to Europe before they could secure the necessary encouragement. We have changed all that, however, and to the Navy belongs the credit for bringing to the native land of the airplane, the blue ribbon of the aerial seas.

Before these lines are in print it is probable that two of the contestants for a straightaway flight from continent to continent will have made a successful landing in Europe or dropped into the sea. Both are military bombing biplanes, and both are driven by Rolls-Royce engines. The NC-4 made her trip with Liberty motors, and so the contest will give a good line upon the two types of drive. The Vimy bomber has two, the Handley-Page four engines.

Granted good weather and clear skies for navigation, and the question of winning or losing is entirely one of the endurance of the Rolls-Royce engine. So far as we know, it has never been put to a test approximating this one in severity.

The NC-4 and this Handley-Page bomber are huge machines; but the end in size and weights is not yet. The Tarrant triplane, built by the Royal Air Force, with its weight of 22 tons, its lifting surface of 4,950 square feet, and its six engines of 3,000 combined horse-power is so much greater as to be in point of dimensions in a class by itself. This machine would not appear to be available for transatlantic flight; for with 10,000 pounds of oil, using all engines with full throttle, the endurance at 113 miles per hour would be only 900 miles. Using four engines and throttling down would enable the machine to cover 1,200 miles, which is about 750 miles short of the airline distance from Newfoundland to Ireland. In its first attempt to leave the ground the machine was badly wrecked. Necessarily, the super-landplane will encounter its most serious problem in the matter of starting and landing.

Think Nationally

IT was easy for us to understand why anything so radical as moving forward the hands of the clock should have been looked upon with suspicion by the conservative public before the experiment was made. The idea seemed fantastic in the extreme. But why should there be any opposition to the conservation of daylight now that the measure has been given a fair trial and has proved so popular through the country? This we fail to understand.

It is true that daylight saving was adopted as a war measure to conserve fuel and as a war measure it paid no attention to public convenience or public prejudice. When, however, we had experienced the blessings of an added hour of sunshine in the afternoon it seemed to us that the new summer time would be a permanent institution. On every hand we heard the measure commended; hence it was with a distinct shock of surprise that we learned of the rider placed on the Agricultural Appropriation Bill last winter. Fortunately, it was a simple matter to dispose of the rider on a point of order and we had hoped that opposition to daylight saving had been definitely and finally killed. But the Committee of Interstate Commerce has reported a repealer as a separate measure and probably before this paper has been published the measure will have been considered and passed upon by the House.

If not too late we wish to register a most vigorous protest against any attempt to repeal the daylight saving measure. We have tried to look upon the measure impartially and to weigh as carefully as possible all the arguments against it, but we have been unable to find any ground for its repeal and we cannot comprehend the motives underlying the opposition to the measure. Apparently the farmer finds daylight saving irksome, but he shows no disposition to adjust himself to new conditions. He does not take the matter seriously but looks upon it as a new-fangled notion which is a bother to him and of no real benefit to the country at large. It seems strange indeed that the man whose day is long as that of the sun, who is out in the open from dawn to sunset, should do anything to prevent men who are cooped up in city offices and who have to toil in factories, from sharing with him some of the benefits of outdoor exercise. Why should the outdoor man want to keep the indoor man in? The whole opposition seems to be due to a narrow point of view on the part of the farmer. We would urge him to "think nationally" as Roosevelt put it. Any fair-minded man who considers the measure broadly, from all points of view, cannot fail to realize the immense advantages to the country at large of starting work earlier in the day and closing work earlier in the afternoon.

This country has always been very fair to the farmer. He has had practically everything he has asked for. It is time he showed more consideration for his city brothers, and we would also remind him that it is the ex-farmer—the man who was brought up in the country and who loves the broad outdoors and who is now obliged to spend his time in the city—who is most enthusiastically in favor of "summer" time.

What Shall We Do with Our Ships?

THE shipbuilding program has been greatly reduced since the signing of the armistice, the Shipping Board having suspended or cancelled contracts for 754 ships, aggregating 2,532,000 gross tons. We have built and expect to build 2,434 vessels, aggegating 9,257,000 gross tons, the total cost of which will be $2,861,755,570. The total sum authorized by Congress for new ships was $3,671,000,000. The Shipping Board asks for a further appropriation by Congress of a sum of $673,368,301.

What does the nation wish to do with these ships?

It is with a view to getting an answer to this question that Mr. Hurley has followed a policy of frank disclosure and discussion. Through the press and on the platform he has made known the policy of the Shipping Board, and the country has been fully advised of the progress of our yards in turning out the ships. Already we have a large fleet and it is growing by leaps and bounds.

The time has now come when Congress must determine what disposition shall be made of the fleet, and for Congress to act it must know what are the wishes of the country in the matter of control and use. Manifestly, the first question to be decided is whether this great fleet shall be owned and operated by the Government or whether the ships shall be sold outright in the open American market and be operated by the individuals or shipping companies who purchase them.

With a view to obtaining an answer to this question, that should be representative of those interests that are most immediately concerned, Mr. Hurley has appeared before the more important commercial bodies throughout the country, and recently invited them to a meeting in Washington, for a joint discussion. The gathering was widely representative, the delegates representing every section of the country and all the leading associations that are concerned in the expansion of our foreign trade and commerce. The gathering included representatives of the Shipbuilding and Shipping interests, the Marine Insurance companies, the Chambers of Commerce of the leading cities, the Trade Bureaus and Councils, the American Exporters Association, the American Federation of Labor, the Farmers National Council, the National Grange, and representatives of the leading railroad systems.

It is impossible to do more than outline the general trend of the many opinions offered; but it was evident, early in the discussion that there was a practically unanimous sentiment in favor of private as against Government ownership and operation. What feeling there was in favor of Government control came from one or two representatives of labor and the agricultural interests. It was noticeable that not only did the speakers who have a working knowledge of the shipping business advocate private ownership and control, with Federal assistance until the new venture is firmly upon its feet, but they insisted that, so far as operation was concerned, the purchasers of the ships should be allowed to operate them entirely free from Government interference. It will be remembered that the proposal of the Shipping Board called for provision for a general Board of Directors in Washington, which should include a Government representative sitting as member of each Board of Directors of the purchasing companies.

It was the opinion of the meeting that all the wooden ships should be sold in the world's markets, and that all steel ships of less than 6,000 tons should be disposed of, 6,000 tons being the smallest size that can be operated to advantage in the foreign trade. The speed should be not less than 12 knots, and higher than that for special routes, notably those to the principal South American ports.

It was urged that, if the merchant marine is to be a success, it must be popularized. This can be done in two ways: By a well-organized campaign of education, and by a wide distribution of the ships around the whole coastline of the United States. Each port in the country should form shipping companies for the purchase and operation of the vessels, and an effort should be made to get public money into the local shipping companies. The Shipping Board should see to it that the ships are well distributed and that they do not all go to a few of the leading ports—a most important point if a wide national interest in the movement is to be secured.

Strong emphasis was laid upon the need for a broad Federal Charter for the ships. No State should pass discriminating laws. There must be one great National scheme, not a series of local and independent State efforts.

Hitherto the indifference of the Middle West to the upbuilding of the merchant marine has been the great stumbling block; but it is believed that the war has served to enlighten the farmer. He has learned how greatly he was hampered by our own shortage of ships. The President of the Kansas Agricultural College said that the farmers were already taking a broader view of the question, that they are not in favor of Government ownership, and that, if the true facts of the shipping situation as affecting their particular interests is concerned are made clear to them, they will favor the granting of Government assistance in the pioneer work of establishing our flag on the seven seas.

To Our Subscribers

OUR subscribers are requested to note the expiration date on copies of SCIENTIFIC AMERICAN. If they will send in their renewal orders at least two weeks prior to the date of expiration, it will aid us greatly in rendering them efficient service.

Electricity

Iron Pipe as Conductor.—The 24,000 kva. 66,000-volt outdoor substation at Hog Island is one of the many substations built during the war in which iron-pipe conductors are used, states the *Electrical World*. In that installation all primary conductors except those to transformer terminals were made of iron pipe. Other companies in different parts of the country used iron pipes for high-tension busbars and for primary connections in substations. The practice has proved so satisfactory that many companies are continuing to use iron pipe for these purposes, though the war restrictions on the use of copper have been removed. The iron buses on outdoor substations are usually galvanized.

Fires Due to Wireless Waves.—At first thought it seems highly improbable that any fire could be ascribed to the effect of wireless waves, though it is conceivable that, granted certain specially favorable conditions, the kindling of a spark between adjacent metal parts might have such effect. M. Le Roy in a recent issue of the *Comptes Rendus* describes experiments intended to test this point. He had met with several cases in which fires did appear to have been caused by wireless waves. Accordingly, he constructed an "inflammable resonator," by the aid of which he did succeed in setting fire to paper, cotton wadding, and other substances. He thinks it possible that in certain conditions inflammable substances, such as bales of cotton bound with hoop iron, could be set on fire by wireless means.

Electrical Effects in Vibrating Wires.—A recent communication to the *Proceedings* of the Royal Society by Admiral Sir H. B. Jackson and Dr. J. B. Bryan refers to the effect of the surface of vibrating wires on the electric currents generated in them by the earth's magnetic field. Rusting, for example, diminishes the current, but the decrease is not entirely due to smaller sectional area. Such currents can be detected by search coils, and somewhat similar effects take place in vibrating plates. The effect is not produced in non-conductors, but it seems to be accepted by the authors that, after allowance for the effect of motion in the earth's field, there still remains an effect which cannot be accounted for. In any case such effects may be of appreciable consequence in telephone and other circuits in which intermittent currents are involved.

Shock-proof Tungsten Lamp.—Despite the many improvements introduced in the manufacture of tungsten lamps, they have remained delicate until the present. There was a time, of course, when tungsten lamps had to be handled with extreme care to avoid jarring and shattering the delicate filament; but in more recent times the tungsten lamp has come to be fairly rugged and available for almost all purposes save in mills, printing plants, and other places subject to intense pounding or shocks. It has remained for one of our leading electric lamp manufacturers to introduce a new type of tungsten lamp which incorporates a shock-absorbing feature. The filament mounting, instead of forming an integral part of the glass stem as is usually the case, is spring supported. This feature makes this lamp serviceable and preferable under almost all conditions where carbon lamps have been used heretofore.

Substitutes for Rubber-Insulated Wires.—In a recent issue of a German periodical there is an interesting discussion concerning tests made in various "war wires," particularly in respect of mechanical strength and resistance to moisture and heat. The insulation on the wires investigated consisted of regenerated rubber, bitumen or a series of layers of impregnated paper strip wound on spirally. The last-named system of insulation gives particularly good results, equal in fact to the results given by the best pre-war rubber-insulated conductors. Compared with the latter, paper insulation does not "age" appreciably; it is less affected by prolonged heating and has great uniformity of quality. The substitutionar insulations considered do not involve the use of imported raw materials, and it is considered that they may continue to be used after the war. Tests of this wire showed excellent uniformity. The wires insulated with bituminous "substitutes" became quite eccentric with the insulation after 20 hours at 50 deg. C. Regenerated rubber is less objectionable in this respect. Paper insulation is unaffected mechanically and loses only 20 per cent breakdown strength at 75 deg. C., as compared with 39 per cent in regenerated rubber and 73 or 74 per cent in bituminous insulation.

Astronomy

Four Periodic Comets, all of short period (6½ to 8 years), are due to return this year. The following approximate dates of perihelion passage are given in the Observatory: Comet Finlay, October 6th; comet Kopff (1906 IV), September 2d; comet Holmes, December 1st; comet Schaumasse (1911 V), December 10th. These dates may be considerably in error, as allowance has not been made for perturbations.

The Astronomical Day.—The movement in behalf of making the astronomical day begin at midnight, so as to coincide with the civil day, has borne fruit in Great Britain, where the Admiralty has just given instructions to have this reform adopted in the British Nautical Almanac, beginning with the issue for 1925. This step was taken after consultation with the Royal Astronomical Society, which, in turn, consulted the superintendents of the ephemerides issued in other countries and various other astronomical authorities. According to *Nature* the change is made mainly for the benefit of seamen.

The Weather Data Needed by Eclipse Expeditions.—In connection with the coming solar eclipse of September 10th, 1925, the path of totality of which crosses Mexico, Prof. W. W. Campbell renews a suggestion which has been made by Professor Todd and other astronomers; viz., that weather observations should be made along the prospective shadow path for a few years before a total eclipse, not only at the season of the year in which the eclipse is to occur but also at the hour of the eclipse. The observations made at the regular term-hours at meteorological stations often give an entirely erroneous idea of the kind of weather likely to be encountered at the time of an eclipse. Professor Campbell says that the data supplied to prospective observers of the Russian eclipse of August 21st 1914, were based on observations made in the morning and evening, and gave fair promise of clear skies for the event. After the eclipse parties reached Russia they were surprised to discover that while clear weather was the rule in the evenings and mornings and at night, cloudiness generally prevailed in the middle of the day, reaching its maximum at about the eclipse hour. The Lick Observatory would not have sent an eclipse expedition to Russia if this condition had been known. In connection with the American eclipse of June 8th, 1918, the data prepared by the Weather Bureau, based on morning and evening observations, gave no token of the fact that in certain localities selected by eclipse parties very troublesome high winds normally prevailed during the period of the day in which the eclipse occurred. These winds gave rise to distressing dust storms.

Dark Markings in the Sky.—Professor Barnard's descriptions and discussions of the numerous dark markings in the sky—possibly non-luminous nebulæ—have already been mentioned in our columns. In a recent number of the *Astrophysical Journal* he again takes up this interesting subject, and gives a catalog of 182 of the markings in question. He believes that some dark places seen in celestial photographs are actual vacancies, but that others are unquestionably due to intervening opaque masses. Whether these masses are gaseous or non-gaseous remains problematical. They are not confined to the region of the Milky Way. Those which occur in that region are not necessarily devoid of luminosity, for they may appear black by contrast with the bright background. Elsewhere, however, there are numerous examples which are perhaps entirely dark. Their visibility leads Professor Barnard to suggest that "space itself is probably filled with a feeble light which forms a slightly luminous background for these dark bodies." Two regions of the sky visible from northern latitudes are especially rich in dark markings; viz., (1) the region immediately north of Theta Ophiuchi, and (2) the region of the great star-cloud in Scutum near the cluster M11. Some of those found in the first-named region are so strange in their shapes that it would be difficult to match them with similar forms among the luminous nebulæ. Professor Barnard recalls the fact that as long ago as 1894 the late A. C. Maynard, then editor of *Knowledge*, in discussing one of Barnard's photographs, declared that certain dark vacant areas "seem to be undoubtedly dark structures or obscuring masses in space, which cut out the light from the nebulous or stellar region behind them." It would be interesting to know whether any earlier suggestions were made to this effect by astronomers.

Aeronautical

New Altitude Record.—On May 28th last, Adjutant Casale, a French aviator, in a flight for altitude ascended 31,000 feet. This constitutes a world's record, being 500 feet better than the flight of Capt. Lang of the British army who in January last ascended to 30,500 feet.

Long-Distance Pilotless Flight.—For some time experiments have been carried out in various countries with the object of controlling aircraft from the ground, and according to the *Journal* a French machine succeeded recently—on a prescribed course with certain specified detours—in covering a distance of 180 kilometers (about 110 miles), and in landing, when required, in a certain airdrome. A similar machine has been developed in the United States which, according to a recent statement of Secretary of War Baker, can travel without a pilot some 100 miles and land close to a designated post.

Argentina's Aviation Instructors.—Argentina has aviators of her own, and does not need volunteer instructors from the United States. Some Argentina officers are now abroad studying aviation in preparation for returning to their own country to act as instructors in military aviation. This advice has been reported to the Secretary of State by the American Consul General at Buenos Aires, in response to a request from the Argentine Minister of War. During the past two months American aviators have been offering their services to Argentina as prospective instructors in flying, but found that they were not needed.

The French Safety and Comfort Competition.—The provisional list of stages to be followed in the *Echo de Paris* tour of France competition, to take place in the early autumn, has now been mapped out. Machines will start from Paris, and will be obliged to stop at Tours, Nantes, La Rochelle, Bordeaux, Biarritz, Toulouse, Barcelona, Nimes, Antibes, Turin, Frejus, Avignon, Lyons, Geneva, Colmar, Strasbourg, Metz, Brussels, London and Lille, ending the journey in Paris. Two of these stages may be flown in one day. The total distance to be covered will be more than 2,790 miles, and the prizes will aggregate some $60,000.00.

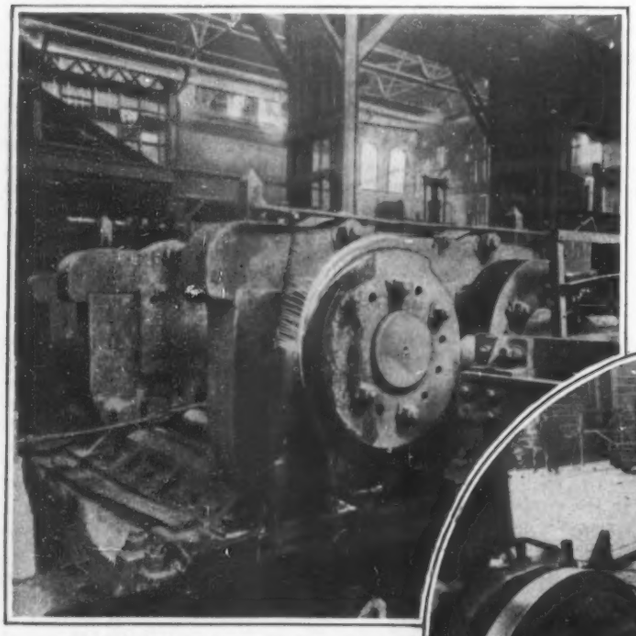
The Peace Treaty and German Aviation.—In glancing over the official summary of the PeaceTreaty, one finds the following rulings with regard to German aerial activities: The air clauses provide that the armed forces of Germany must not include any military or naval air forces. Germany is, however, to be allowed to maintain a maximum of 100 unarmed seaplanes up to October 1st, 1919, to be exclusively employed in searching for submarine mines. The entire personnel of the air forces in Germany is to be demobilized within two months, except for a total of 1,000 men, including officers, which may be retained up to October. The aircraft of the Allied and Associated Powers are to enjoy full liberty of passage and landing over and in the territory and territorial waters of Germany until January 1st, 1923, unless prior to that date Germany is admitted to the League of Nations or is permitted to adhere to the International Air Convention. The manufacture of aircraft and parts of aircraft is forbidden throughout Germany for six months. All military and naval aircraft (including dirigibles) and aeronautical material are to be delivered to the Allied and Associated Governments within three months, except for the 100 seaplanes already specified. General articles provide for the modification of German laws in conformity with the preceding clauses. All the clauses contained in the Treaty are to be executed by Germany under the control of the inter-Allied Commissions, to be specially appointed by the Allied and Associated Governments for which the German Government is bound to furnish all necessary facilities and expenses of upkeep. The duties of the Military, Naval, and Aeronautical Commissions of Control are laid down in detail. Aircraft of the Allied and Associated Powers shall have full liberty of passage and landing over and in German territory, equal treatment with German planes as to use of German airdromes, and with most-favored-nation planes as to internal commercial traffic in Germany. Germany agrees to accept Allied certificates of nationality, airworthiness, or competency and licenses, and to apply the convention relative to Aerial Navigation concluded between the Allied and Associated Powers to her own aircraft over her own territory. These rules apply until 1923, unless Germany has previously been admitted to the League of Nations or to the above convention.

Steel Wheels by a New Process

A Combination of Rolling and Forging that Gives Good Results

By E. F. Cone

A ROLLED steel wheel is now being made in a large western Pennsylvania steel mill by a method and apparatus radically different from anything heretofore. It is called a rolling-forging process. About 15 years ago solid steel rolled wheels were made in the United States from a flat steel slab. Such a blank was punched and pressed into shape, a flat cylindrical form, and then finished in a rolling mill. This procedure was an adaptation of continental European types of rolled wheel centers, but with integral tread and flanges. Wheels produced by this process, while good, contained a steel that varied throughout the circumference. Other manufacturing methods consisted in forging small ingots or forming the wheels from blanks or sections cut from longer ingots, the tread and rim being finished by means of tread rolls.



The big rotary shear with bar entered ready to cut

The new process begins with a standard-size ingot and rolls it in a large two-high mill, thus producing a cylindrical bar from 11 inches to 20 inches in diameter, instead of using a flat slab. Slices in sections are cut off from this large bar by means of a rotary shear, into which the hot-rolled cylindrical bar is introduced. The slices thus cut one after another from the end of this bar produce blanks of any size or weight, adapted to be finished into a wheel or gear blank. These blanks have an outer cylindrical surface of uniform composition, and with the various portions of the steel arranged in radial relation. The rotary shear takes the place of older methods such as using flat slab blanks, short ingots or longer ingots cut into blanks in a lathe.

These blanks are heated in a heating furnace as gradually as necessary for the high carbon steel used in making the wheels. Between the furnace and the wheel-mill proper is a piercing machine which projects a short steel punch or mandrel part way into the center of the blank, making a cylindrical opening in the center thereof. As this blank is introduced into the wheel mill, a loose pin or mandrel which is previously placed in position, is projected into this opening; and as the wheel is pressed and rolled in the wheel mill, this mandrel holds the blank centrally in position and at the same time forms the major portion of the length of the bore of the wheel or blank. The mandrel remains in the wheel or blank throughout the milling and until the blank has been withdrawn from the mill.

The blanks are then transferred one at a time into the wheel mill. This includes a pair of dies so arranged that the axis of one of the dies is at an angle to that of the other die. A hydraulic plunger of enormous size projects one die towards its companion die and an electric motor which can develop from 1,000 to 2,000 horse-power, or thereabouts, dependent on the size and amount of work to be done on the blank, is provided for rotating one of the angularly disposed dies, which by friction also rotates the companion die and the blank which is clamped between them. The blank is shortened and assumes the reverse form of the dies as the pressure and rotation continue. A thrust of 3,000,000 pounds or more is taken up by thrust bearings which are believed to be the largest in the world. This method has the advantage of rolling the steel under cumulative pressure, thus working every portion of the blank into a wheel or other annular shape. The time required to roll a blank into a wheel varies from 20 seconds for the smaller sizes to about one minute for the larger sizes.

There is provided in the blank a slight amount of excess material, which is rolled out in the edge in the form of a fin. When the rolling is completed, the wheel is withdrawn from the mill and placed in a fin shearing machine. Here the fin is sheared off by rotary shears and the mandrel is pushed out and the punching of the bore finished as shown in the picture on page 651.

The forming dies closing in upon the blank

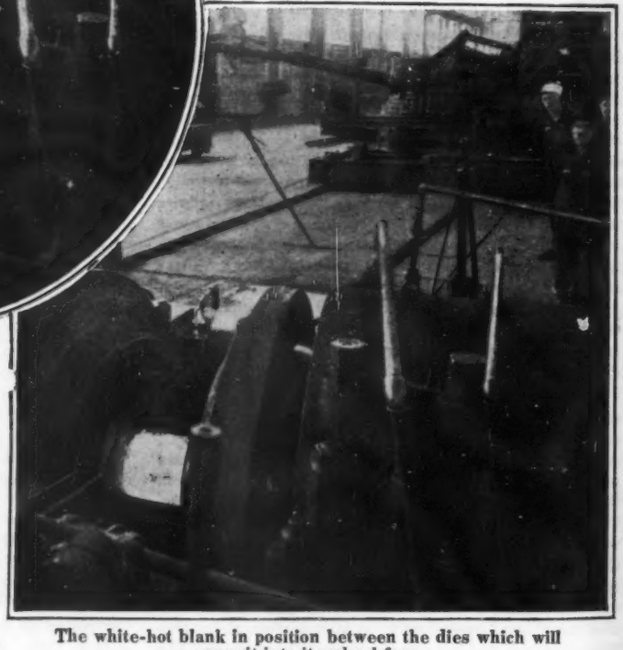
In addition to rolling freight, passenger, electric and other car wheels, this mill is also particularly adapted to rolling gear blanks and automobile flywheels and is especially useful in producing solid tolled wheel centers such as have been used in foreign countries for many years and to which separate tires are fixed.

The rotary shear is designed to cut large bars quickly in order that all the blanks may be cut from one bar before the next bar is delivered from the mill and also to cut these while the bar is still hot. Each blank is cut in about eight seconds. The length of the shear proper is about 36 feet, the length of the feed apparatus is about 60 feet, and the length of the engine shaft or width of the engine is about 16 feet, so that the whole apparatus is about 113 feet long. The width of the shearing machine is about 18 feet overall; the height is 13 feet 8 inches above foundation and the weight approximately 850,000 pounds.

In the operation of this shear, a bar, which is preferably cylindrical in shape, is deposited on the skids and rolled into the space bounded by the side guides. Here it rests upon the long supporting roller, which is then positively rotated by the electric motor and connections in the direction of the rotation of the bar when being cut. The pusher then moves the bar forward until its end rests against the holder adjacent to the shear knives. The shear heads or disks are then rotated in a counter-clockwise direction. As the shafts rotate the eccentric knives gradually cut into the bar from diametrically opposite sides in a spiral form of cut, beginning from the outside and finishing at the center, while during the time of cutting, the bar is rotated both by the shear knives and the frictional driving action of the supporting roller, which is positively driven, as mentioned.

One of the unusual products is a rolled double-flange 24-inch crane wheel. It is first rolled in the wheel mill with a flat tread and this is then introduced into another special tread-rolling mill in which the tread and the two flanges are formed. Heretofore, wheels of this kind have had their treads machined out from a rough blank.

Another interesting feature of the installation is the stacking machine shown on the cover and on the opposite page. This automatically piles up the finished wheels as they come from the machine.



The white-hot blank in position between the dies which will press it into its wheel form

Box Handles of Webbing to Save Shipping Space

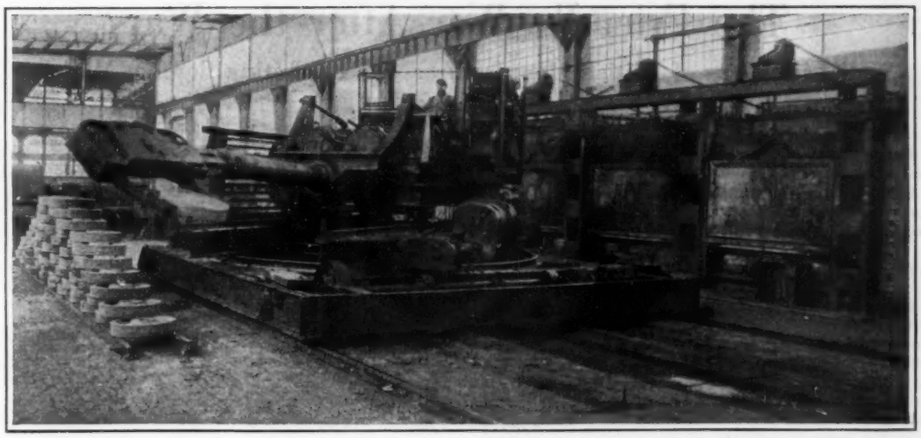
IN export shipment, boxes loaded with 200 to 300 pounds are most easily manipulated when provided with handles. Usually such box handles are made of rope, inserted through holes in the ends of the box and secured with wall knots, or indented into grooves on the under sides of the cleats on the ends of the box, and held in place by nails or screws driven through the cleats.

The former method of fastening has the disadvantage of taking up valuable space in the interior of the box. The latter increases the thickness of the cleats to provide for a groove of sufficient depth to hold the rope, thereby increasing the displacement of the box. Rates are virtually based upon cubical contents.

A box handle made of webbing instead of rope has been suggested by the Forest Products Laboratory as a means of conserving space. For this purpose webbing about ⅛ inch thick and 1½ inch wide, which has a breaking strength of 800 pounds, should prove suitable. It may be inserted through saw-cuts made parallel to the grain in the ends of the box, turned down flat inside, and nailed securely with large headed roofing nails.

Motion-Picture Colony Under One Roof

THE motion-picture industry has grown so fast that it has burst its environment and spilled over into any place where room could be had. As a result, the average motion-picture concern today has studios scattered through city suburbs and far out in the country—wherever land and space could be obtained. Thus one finds the executive offices downtown, laboratories uptown, a workshop in the business district, a storehouse in the factory district, and a property room in any available spot. Needless to say, this has been far removed from anything like efficiency: there has been a vast amount of lost time, wasted energy, excessive cost in cartage, lighting, telephoning—in a word, a great waste of people and things.



Piling the finished blanks with electric transfer tongs

The perfecting of the motion-picture industry in a business sense, so that many perfected units may work together in full efficiency, is about to be epitomized in the new building being erected in New York city by the well-known producer, William Fox. It is probably the first time in motion-picture history that the three leading branches of any producing organization—studios, laboratory, and administrative offices—have been brought together under one roof for the elimination of loss, delay and friction. It will be a little city in itself; an aggregation of all things essential to the production of the photoplay.

The film colony under one roof will be located in the very heart of New York, two minutes from Broadway, at 55th and 56th streets and Tenth avenue. It will spread over a city block, or somewhat over four acres of land. It will house an army of 5,000 workers and will have a producing capacity of 3,000,000 feet of film per week. This film city under one roof will rank among the largest in the world.

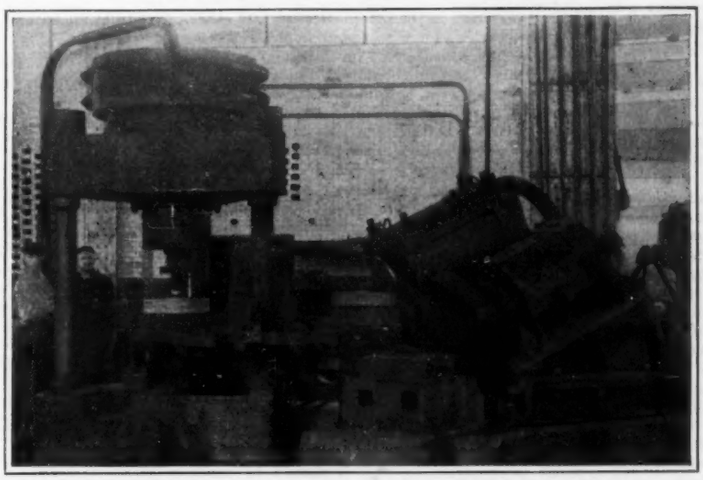
The coming motion-picture colony will consist of three stories and a basement, as contrasted with the 20- by 25-foot studios of a few years ago. It has been laid out along scientific lines by authorities on factory and office construction, with a view to speed, economy, and concentration in every possible phase of efficient motion-picture production, from filming to bookkeeping to stenography and to starring.

In the basement of the building will be a high-pressure boiler plant capable of generating 500-horse-power, a number of enormous coal bins, and a great room fitted with complete electrical equipment for such a building. There are to be extensive quarters for laboratory research work, where a staff of chemical and photographic experts will devote their time to devising and improving mechanical apparatus and chemical formulas for the perfection of photography, film development, tinting and printing, and to general experimental work for advancing technical standards.

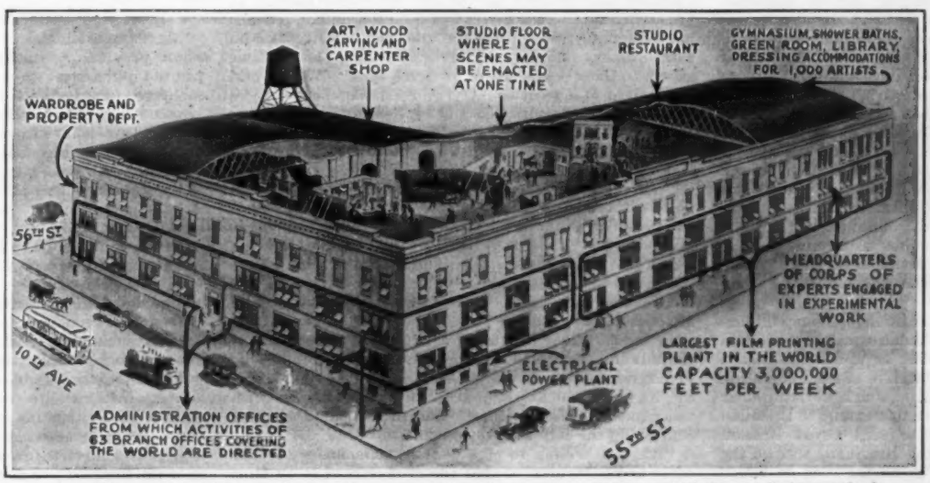
The prize spot of the whole building will be the top floor, which will be in the form of a giant studio that will allow 20 companies to work simultaneously—companies that have heretofore been scattered widely and expensively. The roof will be supported by flying trusses, and not a pillar, post, or obstruction of any sort will prevent directors from setting up scenery wherever they wish. On this floor a director can stand in the center and point to anything he wants to make his picture correctly—things he formerly had to send many miles away to get. Here will be stages both revolving and stationary, property and costume rooms, shops for carpenters, scene and plaster shops, 20 camera dark rooms, and dressing rooms to accommodate 1,000 players. The last word in lighting equipment will be a feature of this studio, and it is said that the cost of this apparatus will be over $150,000.

Safety first! That is the theme throughout the planning and construction of this unique motion-picture building. One unusual feature will be the air conditioning plant, which will supply washed air for the whole structure so that the same temperature will prevail throughout the building during all seasons of the year, and working energy will be assured by constantly cool, moving fresh air. The structure is to be fireproof, of course, being built of brick, concrete and steel, yet at no time will a person be farther removed than 100 feet from an exit. Moreover, three vamps or inclinded roadways will extend to each of the three floors for the use of employees and vehicles, and be wide enough to prevent a jam during a hurried emptying of the building.

One roof will house the big motion-picture colony. Already the foundation has been laid, and the structure is being rapidly pushed to completion. The building will be occupied by film editors, directors, scenario writers, office force, the various film artisans, and so on, and will contain 35 fireproof and waterproof vaults where negatives and prints will be stored; 12 projection rooms, which are to be perfect theaters in miniature, with music and cushioned seats; rest rooms, property rooms, and dressing rooms for 1,000 players. Not least in importance will be the laboratory and research department, which will ensure accuracy in the various details of photoplay. The accompanying illustration gives some idea of the unique motion-picture studio as it will appear when completed.



Removing the circumferential fin and punching the axle hole


ART, WOOD CARVING AND CARPENTER SHOP
STUDIO FLOOR WHERE 100 SCENES MAY BE ENACTED AT ONE TIME
STUDIO RESTAURANT
GYMNASIUM, SHOWER BATHS, GREEN ROOM, LIBRARY, DRESSING ACCOMMODATIONS FOR 1,000 ARTISTS
WARDROBE AND PROPERTY DEPT.
56TH ST.
10TH AVE
HEADQUARTERS OF CORPS OF EXPERTS ENGAGED IN EXPERIMENTAL WORK
LARGEST FILM PRINTING PLANT IN THE WORLD CAPACITY 3,000,000 FEET PER WEEK
ELECTRICAL POWER PLANT
ADMINISTRATION OFFICES FROM WHICH ACTIVITIES OF 63 BRANCH OFFICES COVERING THE WORLD ARE DIRECTED
55TH ST.

An entire motion-picture colony will be housed in this unusual building which is now being rushed to completion in New York City

The Current Supplement

THE airplane was not the product of the war, but it owes its present prominent place in our life and its greatest development to the war. Probably it will develop into other practical uses than those to which it was put in war, but one of its important war uses is capable of extension into peace times. This use is extensively discussed in the SCIENTIFIC AMERICAN SUPPLEMENT for June 21st, 1919, No. 2268, on page 386, by Col. E. L. Jones, Superintendent U. S. Coast and Geodetic Survey, under the caption *Surveying and Mapping from Airplanes*. This very suggestive paper probably indicates the next great development in the Federal mapping of the two-thirds of our domain which still awaits accurate charting. The great increase in airplane building by the Allies created a tremendous demand for suitable paints and varnishes with which to protect these relatively frail structures from the attacks of wind, rain, hail, clouds and salt sea air; the reaction of the paint and varnish makers is discussed by de Waele in the article, *Meeting New Demands*. The ingenious devices that have been perfected to serve the warning light placed at a point where it cannot be constantly supervised, are set forth interestingly in *The Unattended Light*, second article in the series on *Recent Developments in Marine Lighting*. Professor Peck brings out some interesting and generally neglected facts about the *Light-Giving Powers of the Stars*, and also explains how we determine this power. *The Electrical Propulsion of the U. S. S. "New Mexico"* continues to be discussed, special attention being here given to the most interesting motors designed to drive her propellers. They are of the *Continuous-rated Motor* type and under that caption, on another page, Mr. Adams discusses the general nature of the type, its application, and the standardization rules of the American Institute of Electrical Engineers as applied to motors. A classification of the factors that shorten the life of our linen is accompanied by a popular discussion of the *Chemistry of Laundering* from the point of view of the long-suffering customer. Among the shorter articles is one on *Burning Fine Anthracite and Bituminous Coal*. Professor Bancroft's survey of the literature on *The Color of Water* is continued.

The Friendly War After the War

Well Laid Plans of British Manufacturers for Exploiting Foreign Markets

By David McFall

WHEN Great Britain threw her weight into the scale in August, 1914, not one Briton in a thousand shared Lord Kitchener's view that the war would last three years. The man in the street was so impressed by the magnitude of the conflict that its long continuation seemed to him impossible. The general optimism was reflected everywhere. Many of the London shop windows displayed a placard reading, "Business as usual during alterations to the map of Europe." A special war diary, published for the benefit of the Prince of Wales Relief Fund, contained pages for but four months. And innumerable other little manifestations reflected the same conviction.

Indeed, during the entire conflict, even when its frightful cost became apparent, the gist of every utterance was, "Business as usual." While the form of industry was changed necessarily, three-fourths of it being diverted to war work, not for a moment was the inevitable reconstruction period forgotten. It was foreseen that, whatever the disabilities imposed by the war, this period would at the same time present greater difficulties and offer greater opportunities than were ever known before. When America entered the conflict, removing the last vestige of doubt as to its final outcome, dreams of commercial expansion were translated into actual plans. These plans are now coming to light. The linen industry of north Ireland alone has allocated to advertising purposes in America a sum approximating $200,000. The intentions of many other great British industries are no less bold.

The Federation of British Industries

No doubt the most important step taken by British manufacturers in recent years was the formation in 1916 of the powerful Federation of British Industries. This organization, a direct result of new conditions and new problems brought about by the war, is made up of some fifteen thousand manufacturers and producers throughout the Kingdom, representing a combined capital of $2,000,000,000. The Federation is professedly altruistic to the extent that it exists to further the interests of British trade generally, leaving it to each individual firm to take whatever advantage it can from the better conditions thus created.

The keynote of the Federation's task is found in a single word—publicity. The largest expenditure of money, the employment of the best talent, and four-fifths of the machinery of the organization are directed toward this end. In the singularly comprehensive publicity campaign that has been planned, and that is being put into immediate and vigorous effect, there are four outstanding features—a series of international expositions, personally conducted tours through British industrial centers, a fuller use of the moving picture film, and a thoroughly organized newspaper and periodical advertising service.

The British Producer and the Foreign Buyer

Since the opening of the first international exposition in Crystal Palace, London, in 1851, Great Britain has had a greater number of successful expositions than any other one country, though to America must go the credit of having staged the largest and most attractive ones. In the matter of expositions, therefore, British manufacturers are hardly in position to instruct their American competitors. However, the Federation has adopted an attitude which is interesting and suggestive. Instead of putting on one or two large expositions, which experience has shown to be too often more attractive to pleasure-seekers and curiosity hunters than to serious students of industry, it proposes a series of smaller expositions, each more conspicuous for its educational features than for anything else. The first of these will be an Anglo-Greek Exposition, to be held in London in September and October of this year. A representative of the Federation is now in Athens completing arrangements. It is understood that the event promises to be only moderately successful, as would be inferred from the poverty-stricken condition of Greece and her industrial backwardness.

The matter of arranging for personally conducted tours through the principal industrial centers of the Kingdom promises to be much more fruitful, as well as less costly. On April 10th a special representative of the Federation sailed for Brazil, a country with which he is familiar through long residence, empowered to extend to Brazilian importers personal invitations to visit Great Britain. During the whole of the trip the Brazilians will be the guests of the Federation. To avoid the rock on which any such educational mission is apt to split, that of favoritism in being shown certain industries to the exclusion of others, it is planned to have the itinerary cover the entire Kingdom impartially. In each industrial center the manufacturers and their organizations will be invited to meet the visitors both informally and in a business way. Later, similar excursions from other countries will be arranged for. The formation and cementing of business relationships in this way should be of lasting value. It can scarcely fail to be immediately productive, as no one in quest of trade can easily refuse it when it is sugar-coated with hospitality. The fact that the Federation has selected a South American republic for its first experiment of the kind may be rather unpleasantly suggestive to American manufacturers.

Cinema Service for Manufacturers

Perhaps the most interesting proposals—for at this stage they are mere proposals rather than accomplished facts—are those relating to a fuller use of the motion-picture film as a means of circulating information concerning British industries. Heretofore the film has been much more largely used in America than in Great Britain for showing industrial scenes and processes. The reason is obvious. Owing to America's great extent and diversity its own inhabitants are naturally less familiar with their country than Britons are with theirs. Gathering oranges in California or Florida, grinding cane in Louisiana, lumbering in the far Northwest, and other pursuits, are necessarily as new to the great mass of Americans as though they were carried on in foreign countries. This cannot apply within the narrow bounds of Great Britain, where every form of industry, however segregated or localized, is almost within walking distance of every other. Great Britain has also labored under an irremovable disadvantage in the development and use of the film. Due to climatic conditions American films are so much sharper and clearer than British films, and therefore more pleasing, that it requires a subject of exceptional interest to create a preference for the latter. For these and other reasons the British public has accustomed itself to looking upon the film as an interesting enough amusement device, but not as one having any great educational potentialities.

One of the great tasks the Federation of British Industries has set itself is to remove the British misconception as to the value of the film, and to urge a fuller use of it. As illustrating how seriously the directorate views the problem, the following is quoted from an excellently written pamphlet, "Round the World by the Film," recently issued under its direction.

"The influence of the cinema on world-trade development is incalculable, and it should be made a great medium of national advertisement. Producers of films in this country have not been given the same facilities as in America, France, Italy, Scandinavia and Germany for recording on the screen scenes of national life and industry. Abroad, the man with the camera has been made welcome everywhere. In the United Kingdom he has been commonly treated as a nuisance or as engaged in some frivolous pastime meaning nothing to solid business men.

"Within a few years regular attendance at picture theaters has become an almost universal habit. In Great Britain there are over five hundred million patrons per annum, or twelve times the total population. It is an extraordinary anomaly that over 90 per cent of the films shown to these people are of foreign origin. What would be thought of a great country whose newspapers were 90 per cent foreign-controlled and representative of foreign mentality?"

Incidentally, the pamphlet in question pays America this emphatic compliment:

"Through the remarkable enterprise of the American cinema trade the United States is by far the best advertised country in the world. Every day millions of people all over the globe have before their eyes American scenery, American heroes and heroines, American industrial and social backgrounds, offices, factories, farms and households, and American taste in all manner of articles of trade."

In the endeavor to attain for Britain at least a part of the advantages which America now reaps so fully, the Federation makes several practical, concrete suggestions to its constituent members. Correspondence with thousands of manufacturers was invited in a circular containing the following questions:

"Are you willing to give occasional facilities at your office or your works, so that the producers of story films may avail themselves of British industrial backgrounds? Do you make any general exception or qualification in regard to certain departments, or any limitation of time occupied? What features of your business do you regard as being particularly suitable for this purpose (*e. g.*, interesting processes of manufacture, convenient or picturesque or unique location)? Do any suggestions occur to you for giving encouragement to film producers so that the pictures throughout the world shall convey better impressions of British industry and enterprise?"

In the ordinary way, a referendum such as this would not elicit replies from more than thirty or forty per cent of the recipients, at most. But since all who receive these questions are members of the organization conducting the questionnaire, and as each member has pledged himself to support the Federation, in a large percentage of cases the questions were answered readily. The information thus gathered is being recorded and carefully classified. The Federation especially emphasizes that the information will be used impartially, in furthering industry as a whole, rather than in promoting the interests of any one manufacturer.

The method adopted to insure impartiality is interesting. It is expressly urged that in preparing a film depicting the processes of any typical industry, the entire locality in which the industry thrives should be given first consideration. Any particular industry shown will thus form but a part of the film, the historic landmarks, the modern environment and other features of the locality being given the greater attention. This provision would seem to be as effective as it is fair. When the average spectator views a film restricted to the exclusive portrayal of a single industry, it at once occurs to him, at least subconsciously, that it is a paid-for advertisement; but when in connection with it is shown a background of picturesque or historic interest—and nearly every British industrial center has such a background—the industry itself derives additional interest from its setting. At the same time, and almost in the same proportion, all of the other typical industries of the locality share in the benefits of the advertisement, even though individually they might not be suitable for pictorial representation.

The Federation has made another suggestion which is well worth acting on, that individual firms make greater use of the portable projecting apparatus by means of which their salesmen or travellers can demonstrate, in the offices of warerooms of the prospective customers themselves. It is pointed out that the requirements are quite simple—a small amount of wall space, preferably painted or papered in a light tint, and a means of electrical connection, for which any ordinary lamp-bracket is sufficient.

In view of the strength of the British Federation of Industries, and of the methodical, determined way in which British manufacturers usually carry out their undertakings, it is safe to assume that Great Britain at work will soon be figuring largely upon the screen. Indeed, it is quite likely that even American audiences will shortly be witnessing early morning processions of Manchester mill operatives with their shawls and clogs, or of the steel workers of Sheffield, or the artisans in the ugly potteries.

A Larger Use of Printer's Ink

More prosaic is the wider utilization which the Federation proposes to make of the ordinary channels of printed publicity. Some two or three years ago four separate organizations of manufacturers set up a body known as the Industrial Publicity Service, Ltd. The shares were held entirely by the participating associations, which were entitled to neither interest nor dividends, as the sole purpose of the new service was to further national, and not individual, commercial interests. As the result of an investigating committee and its recommendations, the Federation has now bought and assumed control of the Industrial Publicity Service and has taken steps greatly to widen its sphere of influence. It is proposed to make the Service yield a revenue by extending to individual firms the kind of aid rendered by ordinary advertising agencies, and charging the usual fees for such work. The whole of the revenue will be devoted to furthering the interests of the Federation.

The Industrial Publicity Service is now functioning actively in three directions. It is compiling a complete register of British industries; it is preparing technical and descriptive news matter for the foreign press; and it is preparing advertising copy for individual firms, advising as to the comparative merits of various advertising media,

(*Continued on page 667*)

Science in the War

A Resumé of the Work Done by the Bureau of Standards

By C. H. Claudy

IT has been so varied in kind and so large in extent, that by actual count of words a complete catalog of its various ramifications would fill a greater space than is here available. Only a few of the most important phases can possibly here be mentioned. Also it is quite impossible to say of any one particular investigation, report or result that "this is the most important." But it is possible to say of several that "they are not least important."

Certainly among these is the Kolster direction finder, an instrument developed at the Bureau of Standards by F. A. Kolster, and which has already done much to revolutionize the possibilities of wireless as applied to other things than simple message sending. By it, for instance, an airplane can be landed safely in the thickest of fogs, where the pilot has no use of his visual sense. This idea has already passed the theoretical stage and is now in experimental operation on some of the mail planes between the Capital and Philadelphia. In the center of the landing field is a source of wireless signals, which are sent at proper and frequent intervals. The direction finder on the plane locates these signals—somewhere. By turning and elevating and depressing the instrument the direction both in azimuth and altitude is speedily found within an accuracy of one degree. By circling the source of the signals, the aviator is able to "prove up" his location, and by sinking lower and lower as he circles he is able to tell, by the gradual coming to a level of the finder, that he is approaching and finally within reach of the ground.

It seems obvious that this device is applicable to boats—ferry boats seeking their slips in thick weather for instance—as well as to airplanes. By its use coastal vessels could locate themselves with great accuracy off shore by means of triangulation of position from two known sources of signals, the direction of both being accurately determined. In a position of from one to ten or more miles off the coast an error of one degree would not be material as far as running ashore is concerned.

The electrical work of the Bureau of Standards as applied to war has many ramifications. Among them should be noted the complete reorganization and reconstruction of the electrical circuits used in the fire control of big guns. There have been several problems in the application of electricity to gunnery which have never been solved previously and some unexplained "lags" which not infrequently had serious results in affecting the accuracy of fire. The new circuits as arranged by the Bureau of Standards have solved most if not all of the mysteries which previously existed and vastly increased the accuracy of the gunnery.

It is an old story that machine guns fire through propellers on airplanes, and in the case of a fixed gun, which can only be oriented by orienting the plane, the matter can be arranged mechanically with no dependence upon electricity. But with a free gun which can be turned in any direction, there is always the possibility that the gunner may hit propeller, plane, strut or guy wire, bringing down himself and his pilot instead of his enemy. The Bureau of Standards worked upon and conquered this problem, equipping a free gun in a plane with five circuits all of which must be perfect before the gun can fire, and some of them incapable of being closed if the gun is in any position to damage the plane or any part of it.

In no previous war has the Intelligence officer played so large a part as in this one. Never before have the resources of science been brought to bear upon finding out enemy activities and plans as in the European conflict. In aid of this work, the Bureau developed an entirely new method of sound ranging, to locate enemy batteries.

It takes no especial scientific knowledge to realize that as sound has a known rate of propagation, the difference between visual and audible result of gun fire is a rough measure of its distance, and that two such observations at different angles will give some sort of a basis for triangulation and thus location. But to develop the method so that at four miles distance a battery of three-inch guns can be so accurately located that the length of the battery is determined, is another matter altogether, yet to this degree of keenness has the new method been developed and proved. The apparatus, unfortunately for the curious, is not yet to be described for the very obvious reason that the war is not yet over.

In this connection it may be mentioned that there have been numerous investigations, series of experiments, tests and development of ideas and apparatus for war purposes which are not now even being mentioned and that any catalog of the Bureau of Standards' works in war must inevitably be incomplete. Not infrequently work was there done which is known to only two or three men. But there is more than enough which can be described to fill this page.

Much of the work has been concerned with various methods of disseminating or receiving intelligence. Wireless has played a large part in the war and the Bureau of Standards has played a large part in wireless. Through experiments there conducted, a method of applying wireless to submarines was worked out, which enables the sub to receive even when submerged. This sounds odd to the wireless experimenter who has always thought that a free and high aerial, carefully insulated, and a proper ground, were indispensable for receiving etheric vibrations. Yet subs near the Atlantic coast, submerged eight feet, have received wireless messages sent out from Germany.

Another method of signalling which was developed makes use of the infra-red rays of light, which are below the visual range. Infra-red lights can neither be seen, nor recognized easily by photographic means. Yet it is as truly light as the visible spectrum or the rays of the ultra-violet region. The Bureau developed a method by which infra-red signals can be both sent and received, over short distances—that is, from 20 to perhaps 50 miles—and which has the great advantage of being entirely undiscoverable by enemy observers, save by the workings of chance—one chance in billions. Invisible, leaving no trace in ether or air, the infra-red signals of course can only be received when the recipient has his receptive apparatus in position to catch the rays directed to a predetermined point. The method is said to be quite perfect and the application to war work is very obvious.

If there was any one piece of work which could be said to be more important than the rest it might well be that done with gages. Standardization and interchangeability of parts is fundamentally a matter of gages. The accuracy of any manufacturing operation is the accuracy of the gages used and few manufacturing operations require a greater degree of accuracy than the making of ordnance. For years prior to the war the Johannson gages were the world's standard; indeed, the world doesn't know yet how Johannson obtained the utter accuracy of his gages. But now it doesn't need to know. For, as a more detailed account in these pages will soon show, the Bureau of Standards has developed the Hoke gage to a point where it is twice as efficient as the Johannson in both accuracy and quality. Some of them are accurate to the one-millionth of an inch, far beyond the limits of tolerance of the most accurate mechanism. It is generally conceded by manufacturing engineers that the development of this gage marks an epoch in manufacturing at least as important as the development of the micrometer caliper.

It is very interesting to note that the Hoke gage development uses light waves as a measure of accuracy and tolerance. This is probably the first application of light waves to manufacturing, outside strictly optical products. As an instance of the "lag" between discovery and application, it is interesting to note that this development comes 30 years after the interferometer and 20 years after Michelson.

Very early in the war it was determined that when the Liberty motor was an accomplished fact it should be, as far as possible, the most perfect obtainable. One of the first complete motors was taken to the top of Pike's Peak for testing in high altitudes. But it was something of a job and had the further drawback of conducting high altitude tests elsewhere than in a completely equipped laboratory. So the Bureau built a "high altitude chamber" for the testing of motors and carbureters, in which any condition of rarity of atmosphere and barometric pressure and temperature can be produced at will. The investigation, which has gone to a height of seven miles, is not for a few altitudes but for all, so that a complete efficiency curve for any part of any engine affected by pressure and temperature can be plotted. It should not be overlooked here that information as to "how it works" is the fundamental condition which must be satisfied before it is possible intelligently to go to work to make it "work better."

This "altitude chamber" was in use also in testing the cooling efficiency of airplane radiators, which were the subject of a very exhaustive investigation at the Bureau. The experiments were concerned not only with efficiency of the cooling mechanism but with their weight and their resistance to wind. An airplane radiator should give as little head resistance as possible, and yet provide the necessary cooling. Incidentally, it must be noted that there is such a thing as a too efficient radiator. When it freezes at high altitude it is no longer desirable. More than 50 types were considered in these tests, with the result that American planes are models in radiator design.

As an instance of the coöperation of the various laboratories in the Bureau, the spark plug investigation should not be overlooked. To find the most perfect plug on the market or develop one better than any on the market, the Bureau tested plugs from every possible angle, and had working on the problem the gas engine experts, the temperature experts, the ceramic, lubrication, electrical and manufacturing experts, all of whom contributed their mite to the final result. This result, by the way, was accomplished by putting aside every buyable insulating material, and developing a new porcelain in the ceramic laboratories. Liberty engines are equipped with Bureau-developed spark plugs and in all probability the general public will be supplied with them before very long.

A blind man is not more helpless than an army or navy without eyes. The optical instruments used in warfare make a very complete catalog of optical apparatus. Of course field glasses, telescopes and camera lenses come first, but range finders and navigation instruments, periscopes and searchlight mirrors are a close second.

Modern lenses require special optical glass, hitherto supplied this country largely from the great Zeiss works at Jena. At the time the war broke our there was but little optical glass in America, not nearly enough to allow the optical manufacturers to supply the demands of War and Navy Departments for lenses. So the Bureau of Standards developed an optical glass industry and made tons and tons of optical glass, which was manufactured into the millions of dollars worth of optical instruments of precision used in the war. It did not develop merely one or two, but nine different types of glass, so that no manufacturer was handicapped in production either by not getting the right kind of glass or enough of it. In addition, the Bureau developed a method for producing plane glass with parallel sides, such as is needed, for instance in certain small reflectors, *automatically*, a thing which has never heretofore been accomplished, and which manufacturing opticians have always said could not be accomplished.

The development of a cotton fabric as strong as linen for airplane wing construction has already received much comment in the public press. It is well known that the Bureau of Standards has experimented with and developed a paper for wing covering which has much to recommend it and which has ample strength for the strains to be put on it. Nor must the discovery of a means of making cotton blankets as warm as wool be omitted, a simple result which came from tests of the heat insulating ability of various materials, during the period when millions of army blankets and much cloth for army clothing was a vital need and not enough wool in the country or obtainable to satisfy it.

An aviator and his plane are no better than his instruments. The story of airplane instruments is a large one, and the development of their manufacture—for there was no industry of this kind prior to the war—is an inspiring chapter in American accomplishment. The Bureau played a very important part in this development, for it discovered and corrected 28 sources of error in existing instruments. A single instance must suffice. The little corrugated boxes in altimeters have hitherto been made of German silver, a metal which has a distinct "lag" in operation—in other words a rapidly descending plane might easily get 200 feet ahead of its instrument and, if close to the ground in a fog, might easily crash because the aviator, watching his altimeter, thought himself safe when he was really in danger. The Bureau discovered that a five per cent aluminum alloy of copper made the most satisfactory and quickest-acting barometer chamber.

As an instance of the practical application of scientific investigation to money saving, the War Department estimates that by speeding up the hardening of concrete construction, the Bureau saved it $500 a day. The problem was put up to the Bureau: "How can concrete be made to harden rapidly?" The investigation resulted in advice to mix four per cent calcium chloride with the concrete, which results in hardening the mixture

(Continued on page 668)

New Ships of the British Navy

Influence of the Battle of Jutland Shown in the Latest Battleships and Battle-Cruisers

EVIDENTLY the British admiralty believes that the era of keen competition and secrecy in warship design and construction passed with the passing of the German fleet; for that body has recently made public, through papers read by the Chief Constructors before the Institution of Naval Architects, a remarkably complete statement of what was done during the war in the construction of every kind of warship from dreadnought and battle-cruiser down to patrol boat. We publish herewith a set of drawings showing the principal units in this great program, which represents a total of about two million tons, and involved the expenditure of about $1,400,000,000.

When the war opened in 1914 Great Britain was completing the ships of the "Iron Duke" class, which carried ten 13.5-inch guns in five turrets on the center line. Two of these were ready just before the war and the other two shortly after it began. Due to the lessons learned at Jutland, a considerable amount of additional protection was added over the magazines of this class—a change which was made in practically all of the capital ships at the same time. It is interesting to learn that in only one case, during the engagements, was any portion of a shell found to have penetrated below the protective deck. The "Iron Duke" of this class was the fleet flagship of Admiral Jellicoe.

The next class, named after the "Queen Elizabeth," was the first to mount the 15-inch gun, of which eight were carried. The speed was raised to 25 knots and oil was adopted in place of coal. We are told that in the Battle of Jutland four vessels of this class were heavily engaged for several hours; gave and received heavy punishment; but were not seriously damaged or put out of action. Additional protection was given to the magazines as the result of that battle.

The next battleships in order are those of the "Royal Sovereign" class, whose designs were based on the "Queen Elizabeth." To make them more homogeneous with the majority of the dreadnought ships, the speed was reduced to 21 knots; but subsequently a change was made from coal to oil and on its trials, with 4,000 tons of oil, the "Revenge" attained 22 knots which is equivalent to 23 knots at mean draft. The thick protective deck at the center of the ship was brought up to the level of the main deck. Particular attention was paid to underwater protection, and, subsequently to their launching, an outside bulge was fitted to all the ships of this class.

It should be mentioned that the paper read before the Society from which these particulars are taken was given by Sir Eustace d'Eyncourt, Vice-President of the Society, who was responsible for the "bulge" method of protection and recommended it for the "Edgar" class of vessels in 1914.

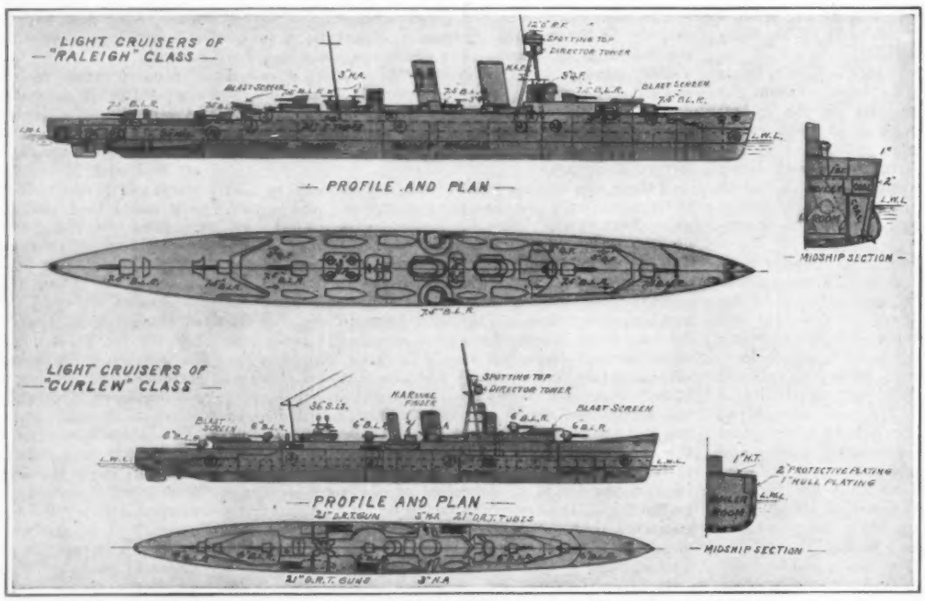
The battle-cruisers "Renown" and "Repulse" of which so much has been written were originally laid down as battleships of the "Royal Sovereign" type; but not much work had been done upon them when the war began. After the Falkland Islands battle the value of the battle-cruiser type became very apparent, and on the initiative of Lord Fisher it was decided to complete the two battleships as battle-cruisers. They were to have a speed of 32 knots and carry the largest number of guns possible. The protection was to be similar to that of the "Invincible" and a modified form of bulge was adopted. As the designs were developed it was found that they could carry six 15-inch guns—four forward and two aft, with a secondary battery of seventeen 4-inch guns. Fifteen of the latter are carried in five 3-gun shield mounts. To save time it was decided to repeat the machinery of the battle-cruiser "Tiger," a 30-knot battle-cruiser of 108,000 horse-power, and with the addition of extra boilers and because of the extra length of the ship, it was found possible to obtain a speed of 32 knots. As a matter of fact, the "Repulse" made 31¼ knots in the deep condition and the "Renown" made 32.6 knots speed at mean draft. A remarkable record of 17 months for construction was made in the case of these two vessels. The ships are being well reported upon in their sea service and they are able to maintain their speed.

Light Cruisers, "Courageous," "Glorious" and "Furious"

While the designs of "Renown" and "Repulse" were in progress, the chief constructor received instructions to design some very high speed ships carrying powerful guns, which were to be capable of maintaining their speed in moderate weather, but were to be of lighter draft than any British or enemy ship of the same class, so as to be able to navigate shallow waters if so desired. It was decided to build "Courageous" and "Glorious" on the lines of very large light cruisers, giving them a few guns of the heaviest caliber, so that they would be able to overtake and sink any enemy light cruisers or raiders. They were to have light-cruiser protection, a speed of not less than 32 knots, and a draft of 22 feet or five feet less than that of any battleship or battle-cruiser mounting such heavy guns. Because the 15-inch gun and its mounting was available, or could be rapidly built, it was decided to arm these light cruisers with 15-inch guns. They also carry an anti-torpedo armament of eighteen 4-inch guns in six 3-gun mounts, similar to those of the "Renown" and "Repulse." They were protected with two inches of armor plate on top of the one-inch shell plating, and a thin protected deck was worked fore and aft which was considerably thickened above the magazines. They also showed the modified bulge under water. They are driven by a four-shaft arrangement of geared turbines, such as is used in the British light cruiser "Champion," the transmission consisting of double helical gearing. With 90,000 shaft horse-power 32 knots was easily obtained on trial and was exceeded in service.

When the "Courageous" was steaming during her trials in heavy weather signs of weakness developed at the fore side of the forward turret, where there is a loss of strength due to the break in the deck structure to admit the barbette. The addition of doubling plates served to correct this. Experience with this ship shows that speeds of 30 knots and over cannot be maintained in heavy weather without danger of overstressing a ship's structure.

The third ship, "Furious," is similar to the "Courageous" and "Glorious" but she carries a more pronounced bulge. In place of four 15-inch guns, she was arranged to carry one of the new 18-inch guns in a single gun turret forward and another aft. Before she was completed, the urgent call from the fleet for fast airplane carriers led to doing away with the fore turret, and building on the forecastle deck a large hangar to house 10 machines, with a 160-foot flying-off platform above it. Later, the after turret was removed and a landing deck 300 feet long, reaching from the funnel aft, was installed. The "Furious" carries ten 5½-inch guns. On trial the ship made 31½ knots with 94,000 shaft horse-power.



Light cruisers of the "Curlew" and "Raleigh" classes built during the war.

The Light Cruisers

The pre-war modern ships of the British Navy were designed by Sir Philip Watts, and among these was the light cruiser "Arethusa" which became famous in the early actions of the war. Subsequently, the British developed some very successful light cruisers of the "Arethusa" type, and it was decided to utilize powerful machinery of a type approximating the type hitherto used for destroyers in order to secure the designed shaft horse-power of 40,000. We illustrate two vessels representing respectively the "Curlew" class and the "Raleigh" class. The "Curlew," 471 feet over all, displaces 4,650 tons and with 40,000 horse-power shows a speed of 29 knots. She carries an armament of five 6-inch guns and two 3-inch anti-aircraft guns. In the case of some of the vessels of the "Curlew" class the horse-power was developed through gearing upon two shafts, which involved a transmission through each reduction gear over 20,000 horse-power, a bold departure from anything that had yet been contemplated. Results however have been very satisfactory. A good feature of these ships is that the guns are all carried on the center line and are therefore available on either beam. The superposed method of fire is adopted so that two guns are available ahead and two astern, a blast screen being provided to shield the gun detachment of the extreme forward and after guns.

The ship's sides to the level of the upper deck are protected by special high tensile plating of from 2 inches to 1½ and 1 inch throughout the machinery spaces in addition to the 1-inch shell plating.

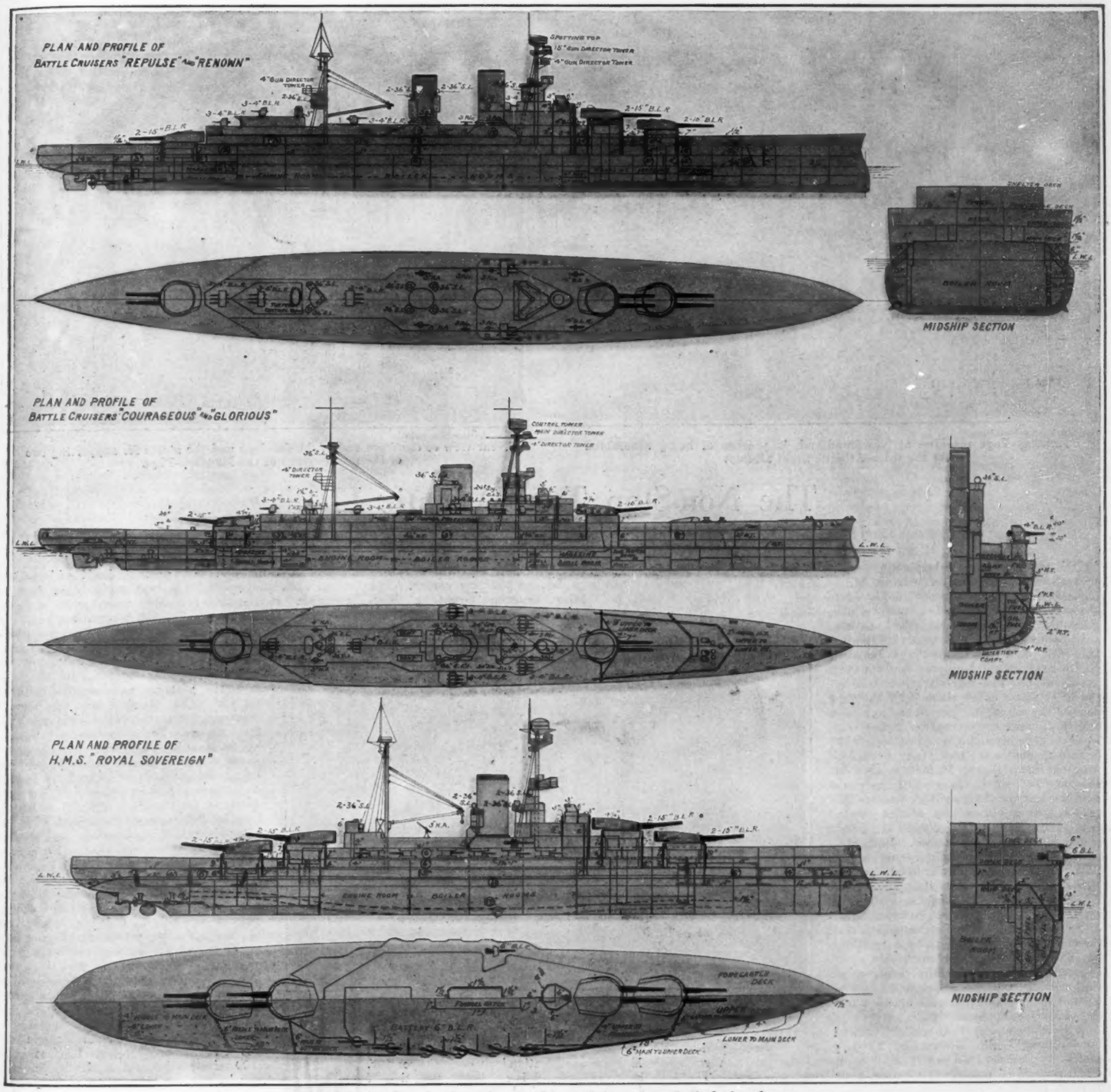
The "Raleigh" class is a heavier type of light cruiser designed for ocean work in any part of the world. Their four-shaft, geared turbine engines of 70,000 horse-power have driven the ships at a speed of 30 knots. These vessels are 605 feet long, displace 9,750 tons, and mount seven 7.5-inch guns, five of them on the center line of the ship and one on each beam amidships. They also carry twelve 3-inch guns, four of which are on anti-aircraft mounting. The maximum side protection is three inches, and the whole armor plan is similar to that of the smaller light cruisers. They also carry the modified bulge below water.

Destroyers

The destroyers, including flotilla leaders, built during the war vary in length from 273 feet over all to 332½ feet over all, the displacement is from 1,025 tons to 1,800 tons, and the speed at load draft from 34 to 36 knots. These are contract speeds which in most cases were greatly exceeded. The world's record for destroyer speed has recently been gained by a Yarrow boat, which in a four-hour run at Skelmorlie has recently maintained a mean speed of 39.6 knots. The armament of the destroyers consists of three and in the later destroyers four 4-inch guns. In the latest flotilla leaders of 1,800 tons and 36 knots, five 4.7-inch guns are carried, all of them on the center line. The torpedo armament consists of four or six 21-inch torpedo tubes. In a succeeding issue we shall give illustrations and full details of the "Turquoise" which is the destroyer that made the mean four-hour speed of 39.6 knots above mentioned.

Monitors

The monitors built for the war ranged in length and displacement from 177 feet and 355 tons to 405 feet and 8000 tons. The 355-ton vessels carried two 6-inch or one 9.2-inch gun; the larger monitors mounted a pair of 12-inch, 14-inch or 15-inch guns.



British battleships, battle-cruisers and large light cruisers built during the war

Blind Men in Testing Laboratories

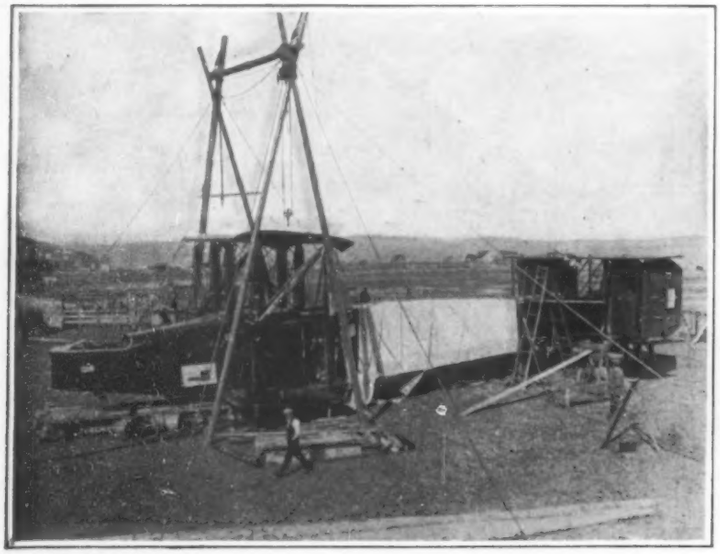
IN 1916, 50 blind men, war victims, were placed in the fireworks laboratory, part of the military munition works of Spandau, says a British trade paper. They were first trained by women and, later, instructed by blind men. Originally they were only given very simple test work of the "go" and "not-go" kind. The dreary monotony of this occupation proved very bad for them, however, and the scope of their work was gradually widened; they were allowed the use of files, drills and groove-cutting tools, and finally of lathes and milled cutters. Special devices had to be designed for their protection, of course; the lathe is stopped, for instance, when the tool has done its work for the time, and the piece is automatically thrown into a basket for examination by the man. Frequent changes are made in the routine work. At first the proficiency of the men was low; last year they were said to do on an average of 80 per cent of the work which able-bodied men could have done. Most of the men are married, and the wives, partly occupied in other departments of the establishment, act as their guides.

Paper Bales Instead of Boxes

THE scarcity of shipping space suggested, some time ago, that great saving could be effected by packing textiles and all other soft materials in bales instead of in cases. Many balable goods can be compressed to one-half or one-third their original bulk, thus effecting a reduction in freight charges, a total elimination of the cost of cases, and an economy in the handling. But the substitution of bales for cases could only be effected through the use of a thoroughly protective wrapping inside the outer covering of burlap; for the latter is good only for its ability to hold that bale together, and must be supplemented by something that gives water-tightness.

As the result of practical tests made by various bureaus of the Government, with some commercial assistance, two types of waterproof paper have been selected for this purpose. One consists of two 30-pound Kraft papers cemented together with asphaltum, and then so crimped or crêped that the finished sheet will stretch at least a third before it can possibly break. As a wrapping material it proves to be very strong and it is entirely impervious to water, dampness, dirt, moths, odors, even rats. By its stretching it accommodates itself readily to any shape, just as does the burlap. The second paper is a smooth sheet made of two heavy Kraft papers, one saturated with asphaltum, and the two then cemented together with the same substance.

A pressed bale in a waterproof casing, covered with burlap and strapped with steel bands, not only is safe against every exposure but saves cases or crates, saves labor in handling, saves the handling of empty cases, and when freight charges are based on cubical content saves half of this item. Baling means vastly more than cheaper and safer shipping; it means that the packing-case will be abandoned wherever the bale can be used.



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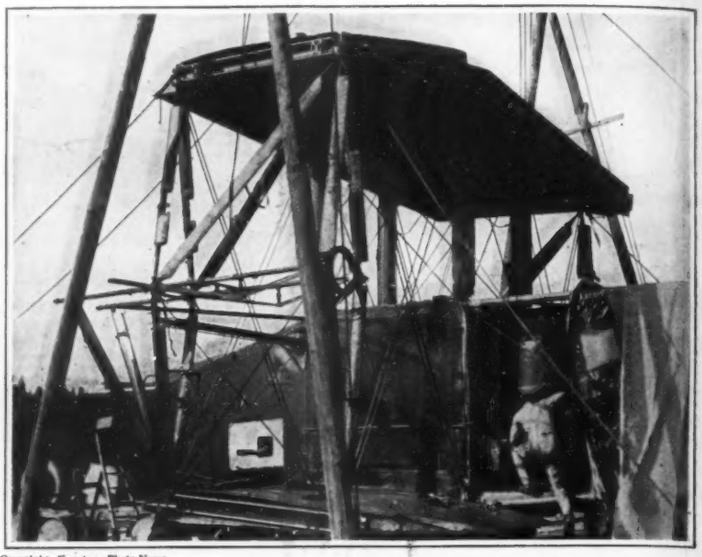
Handley-Page machine at Newfoundland, in process of being assembled for the trans-Atlantic flight attempt



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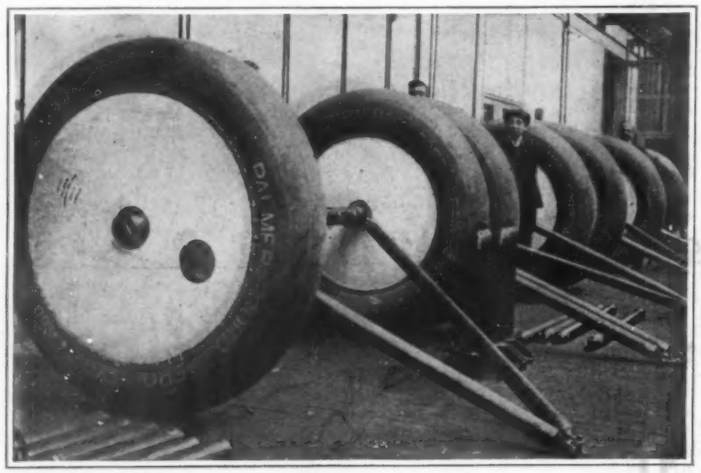
Near view of the front end of the fuselage and the struts for supporting two of the four engines of the Handley-Page

The Non-Stop Trans-Atlantic Flight

Describing the Handley-Page and the Vickers Vimy Bomber Entries

THE non-stop trans-Atlantic flight still remains to be realized at the time of writing. Indeed, while the trans-Atlantic flight has been achieved by the United States Navy seaplane NC-4, there is nevertheless considerable interest still attached to the various contestants now ready to undertake the first non-stop flight between North America and Europe. And the very nature of the non-stop flight, as well as the huge prizes to be claimed by the first successful attempt, gives the present contest a real sportsmanship touch that never fails to invite popular interest.

Two machines are now ready to undertake the great flight; in fact, it may be that one or both of them will have made the attempt by the time this reaches the reader. At any rate, one of the entries is the huge Handley-Page, while the other is the Vickers Vimy Bomber. Both machines are distinctly military machines; both of them were constructed for the British Government for the purpose of bombing Berlin. The sudden ending of hostilities released these machines for other purposes, and the trans-Atlantic flight contest has given them a real opportunity of proving their worth. Multiple-engined, reliable, powerfully built, great load carriers, and fairly fast, both entries are not far from ideal for the ordeal which they have set for themselves.



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Pneumatic-tired wheels of the Handley-Page machine compared with a man and a boy

When the Handley-Page was constructed for bombing Berlin, she carried 1,190 gallons of fuel and a proportionate oil supply, a 200-pound wireless set, 6,630 pounds of bombs, 12 machine guns weighing 557 pounds, and a crew of seven men. She made 90 miles an hour on her test flight with this load. For the trans-Atlantic attempt, however, the machine has undergone some modification. Her gasoline capacity will be about 2,366 gallons, or considerably more than the NC-4 with her 1,900 gallons. This fuel capacity, it is estimated, will give the Handley-Page a cruising radius of 22 hours, or something like three hours' leeway in making the Irish Coast with ordinary weather and no adverse winds.

It is announced that the trans-Atlantic crew will consist of four men—a pilot, navigator, wireless operator, and observation officer. The pilot will be Major H. G. Brackley, who though but 24 years old has had a wonderful military career. The navigator will be Major Tryggve Grant, a Norwegian, 30 years old, who has had considerable experience in long-distance, over-sea flights. Frederick Wyatt of the Marconi organization is to be radio operator.

The Handley-Page attempt is strongly suggestive of the successful one of the United States Navy, for the reason that the matter is being handled in a businesslike and positive manner. The machine itself, as is evident from what has been said, is anything else but small or freakish. It compares favorably with the NC-4, being of the same width, namely, 126 feet, about the same length, or 65 feet, about the same horsepower, or 1,600, possessing the same number of engines, or four, and having considerably more wing surface. Its weight is given as 15 tons, as compared with 14 for the NC-4. It is a land machine, of course, whereas the NC-4 is of the well-known Curtiss flying-boat type.

The Handley-Page promoters have used good judgment in the selection of their flying field, which is located at Harbor de Grace, Newfoundland. The space available for the start is about 900 yards long by 200 yards wide, and all of it has been cleared of obstructions and levelled and rolled, providing a hard surface for the heavily-laden machine.

The Vickers Vimy Bomber, while a big machine by itself, is somewhat dwarfed when contrasted with either the Handley-Page or the NC-4. It is also a land type of machine. Its power plant comprises two standard 350-horse-power Rolls-Royce engines. The capacity of the fuel tanks has been increased to 865 gallons, and the lubricating oil tanks to 50 gallons, and with this capacity the airplane is said to have a range of 2,440 miles, which, needless to explain, leaves a reasonable margin over some 2,000 miles of the straight course. The maximum speed is over 100 miles an hour; but, during the flight across the Atlantic, the engines will in all probability be throttled down to an average cruising speed of 90 miles per hour over the whole course.

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The trans-Atlantic Handley-Page machine, which carries 2,366 gallons of fuel or enough for a non-stop cruise of 22 hours

The span of the Vickers Vimy Bomber is 67 feet, and the overall length is 42 feet 8 inches. The width of the planes is 10 feet 6 inches. The wireless installation is capable of sending and receiving over considerable distances. The pilot and navigator, comprising the crew, will wear electrically-heated clothing.

The pilot will be Capt. J. Alcock of Manchester, England, who has been flying since 1912. He has had a vast amount of experience as a cross-country flier and as an instructor of military fliers. During the war

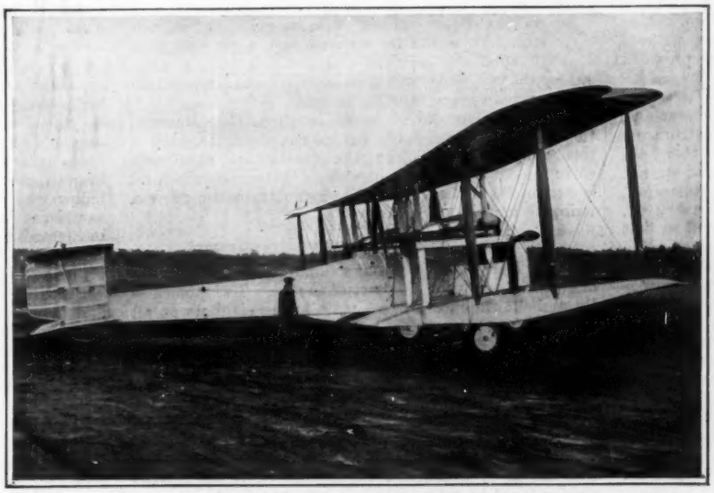
Captain Alcock did good work on the Turkish front, where he won the D. S. C. He was eventually taken prisoner by the Turks, owing to engine failure, and remained as such until the end of the war.

The navigator will be Lieut. Arthur W. Brown, born in Glasgow, Scotland, of American parents. In the course of the war young Brown was transferred from a Manchester regiment to the Royal Flying Corps as an observer, and was wounded and taken prisoner in 1915. He was later interned in Switzerland, and repatriated in December, 1917, since which time he has been engaged with the British Ministry of Munitions on the production of aeronautical engines and has put in a considerable amount of flying at home stations. He is also a pilot of experience and has flown many types of machines.

Lieutenant Brown, after duration tests in the trans-Atlantic Vimy Bomber, considers he will have no difficulty in making a successful Atlantic flight. He intends to rely upon a system of navigation similar to that employed in marine navigation, and will carry radio equipment with a range of 250 miles for the purpose of keeping in touch with surface craft.

The Vickers Vimy Bomber trans-Atlantic flight entry, which has a cruising range of 2,440 miles

Both the Handley-Page and the Vickers Vimy Bomber are equipped with the British engine of engines, the Rolls-Royce, as were the ill-fated Sopwith and the short-lived Martynside. If it comes down to a matter of engine reliability, both machines will most likely be successful, because the Rolls-Royce engine has time and again demonstrated its extraordinary reliability over long runs. Then, too, with more than one engine at their disposal, the crews of both machines can still carry on even with one engine out of commission.



Another view of the Vickers Vimy Bomber, which carries 865 gallons of fuel and 50 gallons of oil

A Better Searchlight Unit

By Albert A. Pashby, Sergeant-Major, C. A. C.

AMERICA'S program in the air during the last year of the war had greatly improved, but what might have been accomplished with new and wonderful devices in 1919 is a topic that arouses the keenest speculation, especially when such a novel product of the minds of Uncle Sam's engineers as the anti-aircraft searchlight is considered.

C. A. B. Halvorson, designing engineer, Lynn, Mass., concentrated his efforts on a lighting apparatus that would weigh not more than 1,000 pounds, combine simplicity with efficiency and contain a 60-inch reflecting mirror. He succeeded in 40 days in evolving a mechanism that had but 20 parts, while the old barrel type had at least 1,000 parts. After an unusually fine test it was accepted by the Government and production was started in big quantities. The armistice came at this point and what might have been instrumental in preventing night raids on such large cities as London and Paris, had to be set aside.

The new searchlight has a divergence of less than three-quarters of a degree, which corresponds to a width of 140 feet at a distance of one mile. The salient features of the design may be found in the novel type of breech-loading cartridge mechanism and in the accuracy of the metal mirror. The magnetic control of the arc permitted a much higher current density at the electrode tips, 400 amperes per square inch being attained, at 65 volts. The diameter of the positive crater of the arc is approximately seven-eighths inch.

The usefulness of the searchlight for anti-aircraft purposes depends upon the accuracy with which the rays of light are tied together by an accurate mirror surface and upon the concentration of the electrical energy at the carbon tips. When one stops to consider that the entire output of light rays must be bunched in a pencil of light subtending an angle of 1½ degrees, some idea of the accuracy may be obtained.

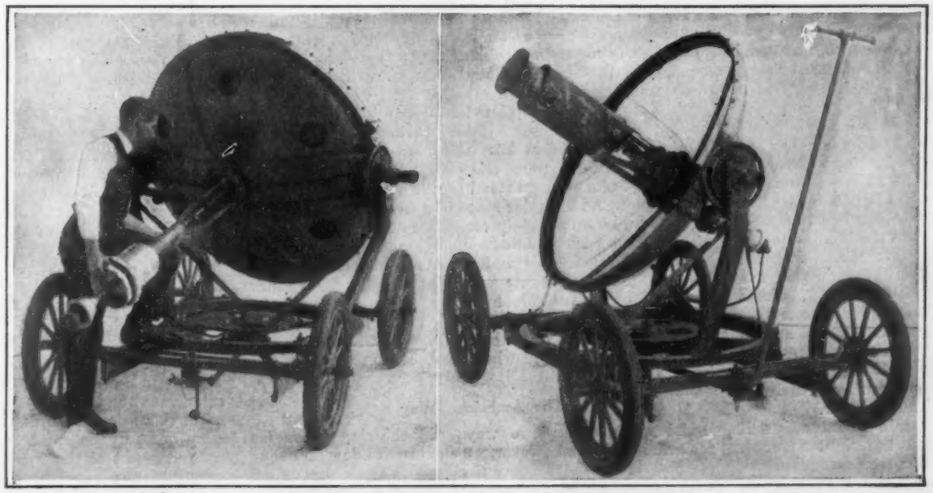
This searchlight is the most powerful in the world, giving a beam of an intensity of over three times that of the most powerful searchlight in use at the beginning of the war; that is to say, for searchlights using a 60-inch mirror, beam intensities of 40,000,000 to 45,000,000 were available, whereas the new Lynn lamp gives 160,000,000 apparent beam candle power. The quality of light is far superior also, the spectrum of light approaching daylight more nearly than any other artificial light sources. This, of course, more clearly reveals the elusive airplane, camouflaged and flying at high speed at a distance of from five to eight miles.

While the searchlight weighs 1,000 pounds it was necessary, in order to make its movements more easily controlled by not more than two men, to mount the entire device upon a light truck equipped with pneumatic-tired wheels. The turntable and trunnion arm supports were of cast aluminum, thus providing a very strong, rugged and light construction. The mirror support is of steel and carried on ball bearings by means of a spoked wheel design and the breech casting, which in turn supports the cartridge-type mechanism and the occulter for warming before the beam is flashed on the enemy planes. The arc controls, feeding mechanism, arc striker, etc., are at the rear of the mechanism and are operated by one man. The orientation of the beam is accomplished by another man operating at the end of a 12-foot radius rod, carrying a mechanism which facilitates the pointing of the beam.

The searchlight and supporting device required a self-contained and complete electric power plant with a generator capable of a 20-kilowatt output. In order to produce this result a 145-inch wheel base chassis was selected. This has an eight-cylinder engine with maximum output of 80-horse-power. An automobile generator with hollow shaft and double-acting clutch was attached. The generator, clutch, governor and other details have a total weight of 650 pounds.

During the war the British used the gasoline-electric omnibus taken from the streets of London and the French attached generators to the Renault trucks to provide a power plant for their searchlights. The new truck unit, including the 60-inch searchlight was responsible for many improvements. The overall weight was reduced 10,000 pounds, the speed increased from 15 to 45 miles an hour and the cost reduced nearly 40 per cent. The new machines weighed, ready for field service, 9,000 pounds. This included fuel, eight-cylinder gasoline engine, 21-kilowatt generator, 300 feet twin cable and reel, switchboard, the 60-inch searchlight with carriage, and the personnel of five men to operate the unit.

During February and March of this year three of these searchlights and power plant trucks completed a test from the West Lynn works in Massachusetts to Calstrom Field, Fla., a distance of 2,000 miles, when the roads were hub deep with mud. The Government was entirely satisfied and though the war has ended, it plans to use the new device at its coast defenses and naval stations.



Two views of the army searchlight that contains 20 parts instead of 1,000, and weighs less than half a ton

To Restore the Ruined Libraries of Serbia

A LEAFLET issued by the Entente Committee of the Royal Society of Literature, in London, describes the wanton destruction and pillage of Serbian libraries during the war, and appeals for aid in the task of restoring these institutions. The Library of Belgrade University, the leading collection of books relating to the Balkans in the whole world and also the most important library in Serbia, was systematically pillaged and destroyed; the large library at the monastery of Dechani, dating from the fourteenth century and rich in historical documents, underwent a similar fate; and many others fared likewise. Every printing-press in Serbia was carried away or destroyed by the enemy.

The American Precision Block

An Industrial and Scientific By-Product of the War

YEARS ago, engines and rifles, watches and other complex machines, in fact all things containing a quantity of parts, were *made*. Each assembly, whether the only one of its kind or one of thousands, was an individual problem; its parts were carefully fitted together by trial, filed and scraped by hand to match as perfectly as possible. Two pieces serving the same duty in two machines could be interchanged only by happy accident; so the bill for repairs and replacements was a heavy one.

Today we do not do it that way. Things are no longer *made*—they are *manufactured*. The immediate concern of the factory is not with the assembled whole at all, but rather with parts. These are made in quantities, often in different shops, and assembled into the complete unit only as a final incident. A broken part is reordered by number and shipped from stock; when delivered it is slipped casually into its place, and as a matter of course it fits and functions.

This quantity production of interchangeable parts is made possible by the system of tolerances. Instead of leaving the problem for the workman to wrestle with every day, the designer subdues it once for all. He carefully calculates just how many thousandths of an inch a given member may vary from the specified dimensions without impairing its fit or its operation. A part is then made with the idea only that it shall fall within the limits of error thus set; if it does so nobody cares about its exact measurements. We are thus precise by appearing to be not precise. A part made after this fashion can be assembled at random, taking its place in any one of the finished machines, without further concern as to whether it will fit the place provided for it and do the work devolving on it.

Behind this development is the magic of the precision gage. This story was told in these columns a year ago, and need not be repeated now. Measuring instruments come in a rich variety of forms to tell us whether balls and blocks and shafts and gears and all sorts of strange and unusual shapes are within their limits of tolerance, whether they must have a shade more metal taken off, or whether too much has already been taken off so that they must be scrapped. But it is begging the question to say that the work is right because the gage is right; how are we able to rely upon the gage to tell the truth?

As recently as a year ago the so-called Swedish blocks afforded univer ally the starting point for precision systems. These are little rectangular prisms of steel, guaranteed to have a pair of opposite faces flat and parallel and a specified distance apart, with no error of any description exceeding one one-hundred-thousandth of an inch. With a set of these blocks of properly selected thicknesses it is possible to build up practically any desired measurement. This can then be transferred to the working gages, leaving the blocks as an ever-present check.

The use of solid master blocks was in itself nothing new. But previously they had been made in the tool-room of the individual factory, with great difficulty and expense, and only in the several sizes required by the work of that particular factory. The whole notion of turning out precision blocks on a commercial basis, in complete sets, within a stipulated accuracy, at a price making them available to every tool-maker, was a novel one. And more than that—the bald claim that the thickness of a pile of the blocks was exactly equal to the combined thicknesses of the members of the pile was in direct contradiction of all previous experience, and could not be accepted without the most rigorous demonstration.

One Plus One Is Two

If we take two ordinary solids an inch thick and place them together, we may get a figure 2.01 inches thick, or 2.001 inches thick, but we will never by any chance get a figure exactly two inches thick. This statement is made without reference to the consideration that the alleged one-inch blocks will fail to measure exactly an inch; for this is not the dominant factor. The big hitch is, that the faces which we have placed together do not fit. They may fit very nicely so far as we can see or feel; but when we get to talking about hundred-thousandths of an inch, we are bound to recognize that their irregularities rule the situation. They are in actual contact in half a dozen places at the most, where high spots of the one meet high spots of the other; elsewhere there is space between them, just as surely as there is space between the carpet and the floor.

Even the Swedish blocks leave minute interstices if they are not put together in just the right manner. Here the trouble comes, not so much from irregularities, as from the tiny particles of air and oil existing on both surfaces. The blocks must be worked together and slid about on one another to force out these particles. When this is done with skill, it is actually found that, in spite of all previous experience to the contrary, the thickness of any group of the blocks is precisely the sum of the individual thicknesses, within the guaranteed margin of error of .00001 inch. In fact, the blocks when treated in this way adhere so strongly that a notable effort is required to pry them apart. This process of bringing the blocks into optimum contact before use is known as wringing.

The reason why the blocks will wring is not entirely clear. At first it was supposed to be a case of atmospheric pressure on the outer faces, which of course is not equalized from the internal surfaces as it would be with ordinary flat objects put together in the ordinary way without the exclusion of air. But atmospheric pressure is only 15 pounds per square inch; and when blocks that have been wrung together resist a pull of 90 pounds per square inch, this explanation is ruled out.

The inventor of the blocks, a Swedish tool-maker named Johansson, thought they were held together by molecular attraction. Ordinarily the spaces between the molecules of two separate pieces are so tremendous, as compared with normal intermolecular distances, that nothing happens. But with the close contact between two almost-plane surfaces wrung together, the ordinary molecular spacing is approached between the blocks, hence the attraction that exists between molecules of a single piece might be approximated. Johansson believed that if the surfaces could be made flat enough their molecules would be close enough, after wringing, to seize upon one another with the full natural grip, so that the two pieces would coalesce at room temperature and we would get a "molecular weld."

Without ruling out all assistance from these factors, the Bureau of Standards has recently put forward a third explanation. When the blocks are absolutely clean and dry they will not wring. When too much oil is left on them they will not wring. And some oils aid wringing more than others.

Surface Tension and Precise Measurement

So the Bureau believes that wringing is a manifestation of surface tension on the part of the oil. The molecules throughout the interior of a mass have neighbors on all sides; those at the surface have the same cohesive power, but fewer neighbors to exercise it on. They can use up their cohesive potential only by taking extra grips on one another. All fluids show the resulting surface tension and surface film; the film on water is so strong that a needle will float on it, if deposited so gently as not to cut through. When we take the incredibly thin layer of oil that separates two almost-plane surfaces in wringing contact, it is practically all surface, and its surface tension must be extraordinary. The Bureau is ready to believe that it is through this tension that the two blocks cling to the film, and hence, indirectly, to each other; and this seems the most reasonable explanation.

Once it was sufficiently demonstrated that, in accuracy of additive measurements and in other respects, the Swedish blocks were as guaranteed, they swept the field. They were cheaper than home-made blocks; they were vastly more flexible; and they presented the first workable means of making parts in different shops to the same exact tolerances. For by no other means could a hundred-thousandth of an inch be carried about from one place to another with confidence that it would not be altered in transit. They seemed the last word in tolerances.

Naturally such a complete innovation in gaging theory and practice aroused great curiosity. Everybody wanted to know, first how the gages were made, and second how they were checked. When a man puts forward 10 blocks guaranteed to run from one-tenth inch to .10009 inch, in regular steps of a hundred-thousandth of an inch, he deliberately constitutes himself the target of questions. These Johansson has consistently refused to answer. Instead of taking patents, he manufactures his gages under the strictest secrecy; and as a fixed policy he seeks every possible means of throwing a halo of secrecy about everything connected with his work. We are asked to speak in hushed whispers of his marvelous skill and ingenuity—in what these consist we must not inquire.

The American Way

Unless there are two ways of achieving the same remarkable result, however, we shall soon know all about it. For right now the very thing which is so surrounded with mystery and hocus-pocus is being done here in the United States. Blocks are being turned out at low cost on a commercial scale, with errors measurable only in millionths of an inch. Contrary to Swedish practice, the whole story of this acheivement will go before the public as fast as it can be presented. For the present we may not tell how the gages are actually made, because of the patent situation. This barrier to complete publicity will soon be down, however; and in the meantime there is a great deal of interest that can be told about the American block gage and the problems met in producing it.

The inventor is Major William E. Hoke of St. Louis—the "Major" being one of the consequences of his invention. In his business he had occasion to use the Swedish blocks, and in such a manner that their square form was a great nuisance. This comparatively trivial circumstance led him to wonder whether he couldn't make his own gages—and with them, of course, gages for other people. He felt that the shape of the Swedish blocks made it necessary to regard them solely as a precision of court-of-last-resort, and that they could never become a real tool; he aimed at a gage of equal accuracy which should be a tool. His experiments began in 1915. They took various directions, and a lot was learned about precise workmanship; but of course for the most part investigation followed false trails. Finally, though, in 1918 Mr. Hoke struck the correct scent, and in a very short time he was able to write to the SCIENTIFIC AMERICAN, announcing in so many words his invention of a better block gage than the Swedish, and asking advice as to its disposal.

Adventures of an Inventor

At the same time Mr. Hoke had written to several big tool-makers, and to two governmental bodies; but he got no encouragement from these sources. He does not hold this against anybody; he admits that such a claim as he advanced might much more reasonably have been supposed to come from a crank than from a regular fellow who knew what he was talking about. But he would not be denied; so after filing patent applications in accordance with the suggestion of the SCIENTIFIC AMERICAN, he got aboard a train for Washington, determined to jam his gage down somebody's throat.

For this purpose he selected the Bureau of Standards; and in a face-to-face encounter, where he could really tell something about his invention, he made such a showing that the Bureau gave him a place to work in, a man to help him, and permission to go to it. In two days he had a machine making gage blocks; and as fast as he turned them out the Bureau tested them, with its regular micrometer outfit, and other means of measuring.

After a week of this, Mr. Hoke was just about ready to pack up and go home. Gages in which he could find no error, and which he had supposed to be accurate to an unheard of degree, the Bureau reported with errors running into the ten-thousandths of an inch. But before abandoning ship, it occurred to him that perhaps the hitch lay in the measuring methods. The Bureau was using strictly mechanical means of testing his gages; and as he cast over in his mind his own experience with such methods, he realized that the probable errors of observation inherent in them were greater than the errors which he had supposed he was getting in his blocks. So he prevailed upon the Bureau to go to the expense of measuring a group of his blocks in the interferometer.

After a day's work, the report came to him that the three blocks thus submitted were accurate and identical within unheard of limits—within millionths of an inch. in fact. So Mr. Hoke stayed right there in Washington; and his progress since then has been almost one continuous triumph. It is admitted that Major Hoke, as we may now call him without getting ahead of our story, actually took a step forward in the conflict between the man who makes and the man who measures. Before he came on the scene, the latter was in the lead, and could measure, by mechanical means, any work that could be produced. But the Hoke gage went past these means of measurement, and forced the adoption of a more delicate, non-mechanical standard of measurement, as the only way to detect its infinitesimal errors.

Measuring with Light Waves

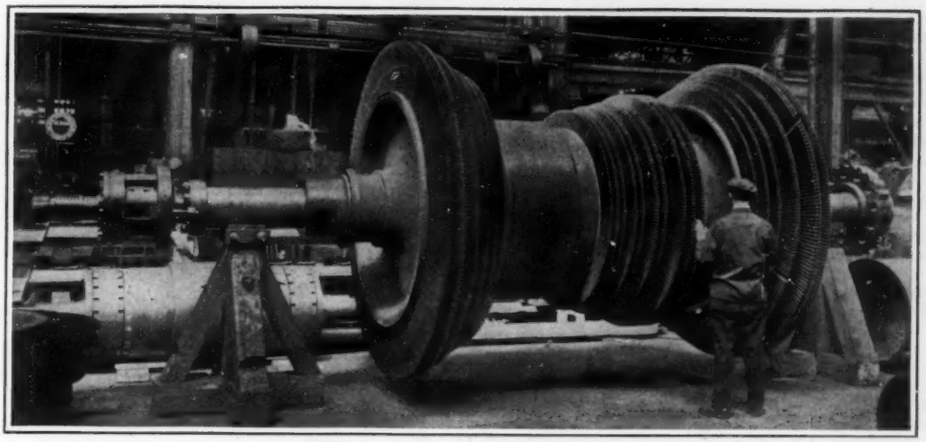
The interferometer measures by dealing with light wave-lengths, which vary between 14 and 32 millionths of an inch for the visible spectrum. It is expensive; it requires a scientist to adjust and use it. It is slow and laborious for the same reason. But it indicates that nothing short of the wave-length of light is sufficiently minute to measure the errors of the Hoke gage. Accordingly the Bureau of Standards was confronted with

(*Continued on page 668*)

One Hundred Thousand Horse-Power Steam Turbine

From Piston to Turbine—Reconstruction of a Great Power Station

IN the SCIENTIFIC AMERICAN of January 11th, 1902, there was published on the front page an illustration of one of the eight great reciprocating steam engines which had just been completed at the new 74th Street power station of what was then the Manhattan Elevated Railway Company. Each unit had a normal capacity of 8,000 horse-power and a maximum of 12,500 horse-power, and each consisted of two compound condensing engines, coupled to a common shaft, with an alternator mounted on the shaft between them. The 44-inch H. P. cylinders were placed horizontally, and the 88-inch L. P. cylinders vertically, the two connecting rods of each engine taking hold of a common crank pin. The huge rotating field, 32 feet in diameter, weighing 185 tons, served as a fly wheel. Each pair of engines weighed 720 tons.



Blading one of the low-pressure rotors

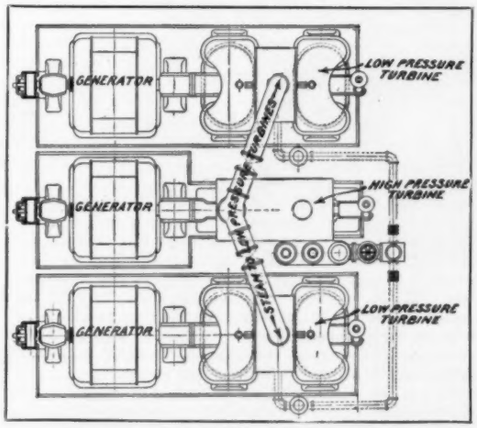
The maximum possible output of the eight steam units with which the building was fitted was 100,000 horse-power.

There has recently been installed in the same plant a single triple-compound Westinghouse steam turbine which has a maximum output exactly equal to the maximum output of eight units, including sixteen compound engines, that previously fitted the engine room.

With the development of the steam turbine, especially in the larger sizes, the economy both in floor space and bulk and in steam consumption of the turbine, was so marked that it was only a question of time before such large reciprocating engines as those in the 74th Street power house would be replaced by the more modern prime mover.

This substitution has been taking place during the past few years. Not only have the reciprocating engines of large power stations throughout the country been gradually taken down and turbine units erected in their place, but there has been a notable increase in the power of these individual units themselves. The first turbines to be installed at the 74th Street plant were of the compound type with high and low pressure elements. Each of these was direct-connected to two generators, there being one generator on the high pressure and one on the low pressure shaft. The maximum output of each unit was 30,000 k. w. These units are shown in the lower left-hand view.

There has recently been completed the great turbine referred to above, which is remarkable as being the most powerful steam engine in the world. It consists, as can be seen from our photographs, of a central high pressure turbine and two outer low pressure turbines. Each turbine is direct connected to its own generator. The steam is led to the high pressure element at 205 pounds pressure to the square inch. After it has passed through, it is led by a bifurcated steam pipe to the low pressure



Plan view of the triple-compound turbine

cylinders, as shown in the accompanying diagram. It enters at the center and the steam flows in opposite directions through the successive rows of blading. From the low pressure turbine it passes to the condensers which operate under 29 inches vacuum.

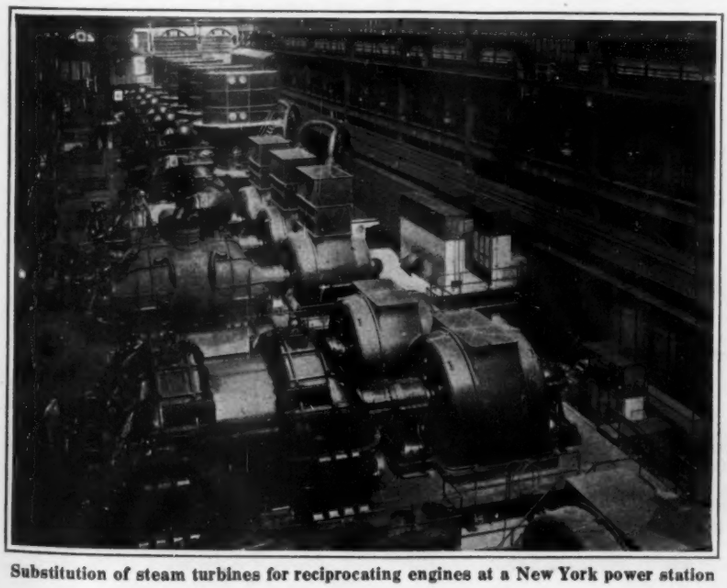
The speed of rotation is 1,500 revolutions per minute and at this speed with 205 pounds pressure at the throttle this wonderful engine has a total horse-power of about 100,000 and the total output from three generators which it operates is 70,500 k. w. The generators are each rated at 20,000 k. w. continuously and they have a maximum output of 23,500 k. w. for two hours. Twenty-five cycle current at 11,000 volts is delivered from the main power house to the substations. The floor space covered by the big turbine is 52 by 50 feet and its height is about 20 feet. When the turbine is running at maximum load, 826,000 pounds of steam pass through the blades of the turbine per hour, and the water rate is less than 11 pounds of steam per kilowatt hour.

The Effect of Great Pressure on the Electric Properties of Metals

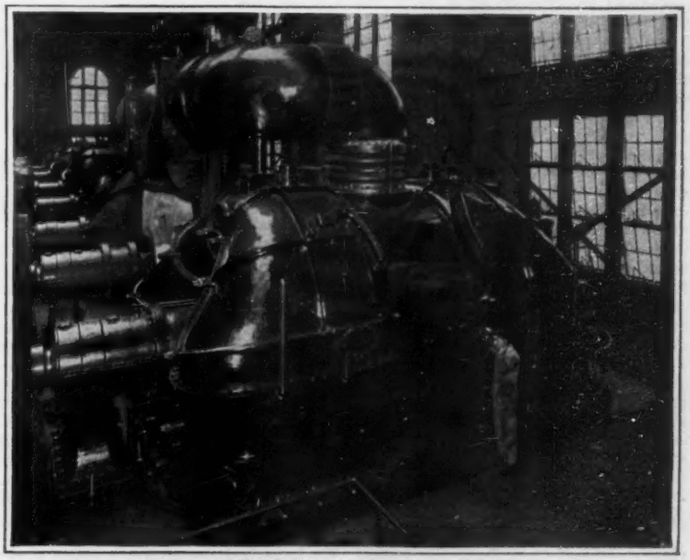
IN the great majority of the metals tested by Bridgman, increase of pressure lessened the electric resistance, antimony and bismuth being the only exceptions.

According to the hypothesis of dual electric conduction the total conductivity of a metal is the sum of the conductivity due to the action of the associated electrons, and that due to the action of the free electrons. It seems that increase of pressure should increase the former and decrease the latter; and as the former is probably much larger than the latter in most metals, we should expect the usual effect of increase of pressure to be an increase of total conductivity, as it is in fact. But in the case of metals for which the ratio of the two phases of conductivity is exceptionally large, as it probably is in antimony and in bismuth, especially the latter, we should not be surprised to find increase of pressure producing a decrease of total conductivity, as it does.

In most of the metals tested by Bridgman, increase of pressure produces such an effect that heat is absorbed when a stream of electrons goes from the compressed to the uncompressed metal, this effect being especially large in bismuth. Now this is what we should expect from what has just been said, for, if the fraction of the current due to free electrons is smaller in the compressed metal than in the uncompressed, ionization must occur, with absorption of heat, at the junction where the stream of electrons passes from the compressed to the uncompressed metal.



Substitution of steam turbines for reciprocating engines at a New York power station



A 100,000-horse-power steam turbine

The Service of the Chemist

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Conducted by H. E. HOWE, Chemical Engineer

The Present Status of Our Dye Industry

HERE in America there are many instances in which the founder of a business has lived to see the establishment grow from a one-man affair to an organization of thousands, but quite generally the process has required years and development has been at a rate fully justified by conditions which could be carefully studied in advance. In the dye industry we have an example of an entirely different way of having to do things.

In many respects and considering the conditions under which it was done the work of giving America a dye industry in four years or less may be considered about the most remarkable single achievement in our industrial history. Unlike other notable advances which have consisted in commercializing new discoveries and inventions or greatly improving upon existing products, the dye manufacturer knew the wares he was expected to supply but at the start he had insufficient raw material, lacked technical and sales organizations, required a plant and was seriously handicapped by the cumulative effect of a long period of skillful competitive advertising.

A discussion of what has been done thus far and something of the present status as well as the possible future of our dye industry may be properly prefaced with a few words regarding the complex nature of the problem and the factors upon which Germany seems to have counted to defeat the project of American dyes made in America by Americans. Attention has been called previously to the history of synthetic dyes; how they were first discovered by Pekin, were siezed upon by Germany and came to be regarded as a one-nation business. We have read that England might have become the home of dyes had one of her universities been disposed to pay a better wage to one or two instructors and had there been a better appreciation of chemical research in the islands. This should serve as a warning to our own educational institutions and industries. A few of our scientists have maintained that the volume of business in dyes was not enough to stand splitting up between several countries and on a straight dollars' and cents' pre-war basis they may be correct, but they seem to have forgotten the relation of dyes to other industries which without them would be greatly impeded if indeed they could exist. These include paints, inks, textiles, leather, paper for special purposes and so on.

Why Germany Thought an American Dye Industry Impossible

The factors which the Germans believed would make an American dye industry imposible included raw materials, technical organization, lack of export trade and inexperienced selling agencies. There was also a large number—between four and five thousand—of German patents, many of them product patents drawn for the sole purpose of preventing competition in America. Then, there was the ever present propaganda which was and is much more potent than many suppose. Now practically all these obstacles have been overcome and the most resistant are gradually giving way. We soon found plenty of many kinds of raw materials and we smile when we recall the solemn assertion often made that the coal tar in America is very different from that in Germany and not at all suited to the needs of the dye business. A large number of plants were soon making aniline and this material often surpassed in quality any that had been imported. We had always produced large quantities of napthalene and a satisfactory grade was soon available. Now that the war is practically over we have a real excess of benzene, toluene and xylene at hand. It is true that the materials which are raws or intermediates for the dye industry alone were very hard to get and for a time the extreme uncertainty of the future caused manufacturers to hold back. Two such substances are anthracene and carbazol, both used in no other process than dye making and necessary for alizarines and vat dyes. Some colors are still wanting due to a lack of carbazol of the proper purity.

The United States has always done well in the so-called heavy chemicals so in that direction all is well. It would seem, therefore, that our supply of basic materials is adequate with the possible exception of anthracene and carbazol where the question is now that of sufficient refining. The quantity of raw material is fully adequate for our needs.

Building Up a Technical Staff

So far as the technical staff is concerned that too has been developed throughout the works. We have had too few organic research men in our country, but the dye emergency has quickly increased the number and it has been possible to draw upon other chemical industries for various grades of men for the different departments of work and laboratory. The technical and research staffs of our dye plants may truthfully be said to have accomplished in four years what Germany has in nearly twenty, notwithstanding the accounts in the literature to serve as guide posts. The properly qualified selling organization has not been wanting as predicted. Many real Americans had been demonstrating and selling the imported article and they were glad to turn their talents toward helping our own industry. Therefore, little difficulty has been experienced although no doubt the proverbial deficiency of the American salesmen in his knowledge of foreign languages and customs is somewhat of a handicap in selling dyes abroad just as it is in any line of American merchandise.

While an export business is highly desirable, it is not necessary to maintain our dye industry which on domestic business at present prices reaches about $100,000,000 annually. It is, indeed, something to have started with so small a nucleus and within four years to have been able to export dyes to a value exceeding that of dyes imported in the year just preceeding the war.

Another field in which we have won is that of large scale apparatus and equipment and our present position is one of security for we can build highly efficient apparatus for all the unit operations and can carry on most of them on a larger scale than is customary abroad. Marked improvements have been made in equipment tending toward efficiencies which will stand us in good stead in world competition.

Fast Colors and German Propaganda

Much has been said about propaganda and we are not yet free from its evil effects. We are still being assured that notwithstanding the retailer's efforts to use the best dyes he can guarantee no colors. In many cases if not all, it will be found that the fastness of the colors to light and washing have never been guaranteed and that there is no justification for the policy originally intended to make it more difficult to introduce American dyes. We now know that the large majority of the imported dyes would not withstand the tests to which our dyes are subjected any better if indeed as well as do the American compounds. One of our largest producers has prepared a large exhibit which clearly proves this point and the many who have examined the display have found ample reason to be proud of our progress and to have confidence in our dyes providing they are properly used.

In order to cover this last point, the dye makers stand ready to assist users in the proper application of their product and at least one manufacturerer offers service without compensation or obligation to those handling the dyed fabrics in case of dissatisfaction. This service strives to determine whether any fault is with the dye, its application, or both, and seeks by coöperation to prevent recurrence. It must be borne in mind that our condition is constantly improving and the fact that we may have had trouble six months ago is not to be taken as a criterion for today. For example the blacks used on hosiery used to be developed colors. These were not available in the early war days, but direct and sulfur colors were. These require somewhat different technique in their use and the direct color is less fast to washing than developed dyes while the improper use of sulfur colors may cause tendering of the yarn. Well, those days are largely past. The dyer knows how to use sulfur colors; and developed colors, by which is meant those which are developed by chemical reactions on the fiber, are now to be had here.

Much of the dissatisfaction with American dyes has been due to the limited range of colors which in reality was just about as unimportant as anything could be considering that we were making very large amounts of the colors required for the military establishment. Even in normal times the fancy shades make up little more than ten or twelve per cent of the dyes consumed and during the war the situation could have been helped by designing the styles with due reference to the colors that could be had. Black, blue, red, brown and yellows make up the tonnage in dye production and our problem here was to make first what the army and navy needed and to make it of uniform quality in quantity. That was done. The variety of shades is constantly growing in number and these are also of much better quality as regards fastness to light and washing now that there is time to work out efficient purification applied to raw materials, intermediates and finished dyes. The vat dyes which have been in such demand are beginning to appear, while the indanthrenes, the only colors which withstand bleaching with chlorine, are not out of the laboratory as yet. The work is progressing well, however, the experiment may be carried to the small-factory stage nearly any time and following that our demands will be satisfied.

A Twenty-Year Growth in Five Years

Obviously all this could not have been accomplished without adequate facilities and competent specialists to operate the plants. All this is now in good shape. Our dye companies increased their output enormously, added to their lines, improved the quality of their product, rebuilt their plants and organized groups of men to carry out the plans and man the factory *all at the same time* in a field admittedly the most complex in chemistry. Perhaps it can all be put in one sentence and made strong for those who measure things by a German standard, wishing for the days when they may have German dyes again, by saying that in some five years we in America have done as much in the dye industry as Germany did in the 20 years previously, changing our country from the import to the export column at a time when most factors were adverse.

The present status of the dye industry is, therefore, that we have acquired the plants, the personnel and the technical experience. Proper selling and demonstrating organizations have been created. A large amount of export business has been done and in fact all the obstacles that were guaranteed to make an American dye industry impossible have been overcome. Research laboratories, carefully planned and equipped and in the best hands, are working out many new things and when these are ready they will be taken to the semi-commercial scale of production where the creases that normally appear when work begins on twenty-five or one hundred pound lots may be ironed out. It always pays to make mistakes on a small scale and successes on a larger one. While the German patents are deceiving they were a stumbling block to us because many were product patents. The formation of the Chemical Foundation was a very clever way to cut the trust so that we may now use these patents not only to aid manufacturers, but to protect them against the competition of German products themselves. These patents, therefore, have become a help rather than a hindrance. What are we to do to keep such a promising industry in good condition until it can stand alone?

Many will point to the invested capital of several hundred million and our last complete statistics and declare that the industry can care for itself. In 1917 190 firms manufactured coal tar chemicals, 118 concerns produced intermediates and 81 establishments engaged in the manufacture of dyes, many making but small quantities for their own use. Now what dangers beset us?

Present Condition of German Plants

Major T. W. Sill has investigated the German plants and reports them in excellent condition notwithstanding numerous reports that they had been damaged by air raids, etc. Some of the more prominent works were fortified against attacks from the air and the trained technical staffs were likewise protected by the pre-war classification system which, based on a man's utility to the country, conserved this grade of labor from the start. Germany stands ready today with clean, well ordered plants, organization and skilled workers ready to plunge into the world's markets and try to win them back at all costs for her dyes. The only things she lacks are coal and certain other raw materials which the Allies can control if they will. Then there is the question of German control of certain plants in other lands so there can be little doubt but that we must find a way to meet German competition with all that experience has taught us that means.

Then there is the competition of friendly countries such as Great Britain where the Government has taken a much larger part in building up the industry than has the American Government and has already taken vigorous steps to protect it. Synthetic dyes, having originated in England, are to be invited to make their permanent home there.

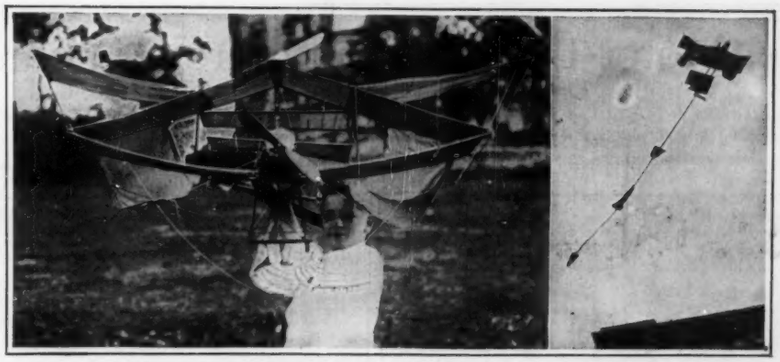
Protection of Our Dye Industries

What may be done to fortify our position? Congress seems to consider protective measures necessary, but at

(*Continued on page 668*)

The Last Word in Airplane Kites

KEEPING step with the developments of military aviation, our young boys have recently turned their attention to airplane kites to take the place of just plain kites. The airplane kite shown in the two accompanying illustrations is perhaps the last word in such toys. It measures four feet three inches in length, and has a wing spread of three feet. It is made of light wood and the wings are covered with silk. This airplane kite carries three propellers, two in front and one at the rear, which revolve while the kite is in flight. With moderate winds the airplane kite requires no tail, and flies high and steadily; but with strong winds a tail must be used. All in all, this kite is sufficiently like an airplane to stir the imagination of any youth and put plenty of new interest into the otherwise prosaic pastime of kite flying.



Two views of an airplane kite which climbs to high altitudes and flies steadily in moderate winds

German Submarine Dry Dock and Testing Tank

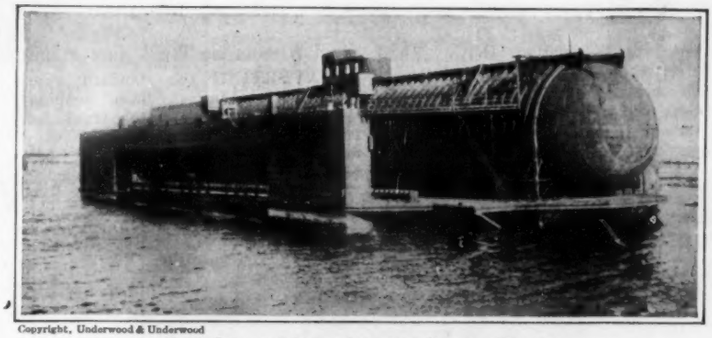
AT the north end of the Kiel Canal an Allied Commission found the submarine dry dock and testing tank which is herewith illustrated. It represents a type which is used, with various modifications, by other naval powers, and, so far as our information goes, the first to design and build anything of this kind were the Italians. In our issue of May 8th, 1915, we showed an Italian mother ship for submarines—a large sea-going craft of about 3,000 tons, capable of a speed of 14 knots, which carried enclosed within the hull a submarine testing tank 210 feet in length and with a diameter of 23 feet.

This German tank is mounted upon a modified form of floating dry dock. The tank proper is cylindrical in cross-section with a hemispherical front end. At the other end is a gate, through which, after the tank has been submerged, the submarine enters and is secured in place. The object of these tanks is to subject the submarines to a hydrostatic pressure equal to or greater than that corresponding to the maximum depth of water in which they are intended to operate.

Before the war our boats were designed to withstand a pressure corresponding to submergence to a depth of 200 feet below the surface of the sea. We believe that during the war the capacity for deep submergence was increased.

The advantage of the use of such tanks is that, not only can the newly constructed submarine be tested to ascertain if it is satisfactory as to strength and water tightness, but subsequently, after it has been subject to the wear and tear of service, it can be periodically placed in the tank to see if there has been any deterioration in these respects.

It will be understood that these tanks have to be built of great strength to withstand the great pressure to which they are subjected. At 200 feet of depth this amounts to over six tons to the square foot, and at 300 it is over nine tons. Hence the spherical ends, and the heavy and closely spaced circular ribbing which shows in the engraving.



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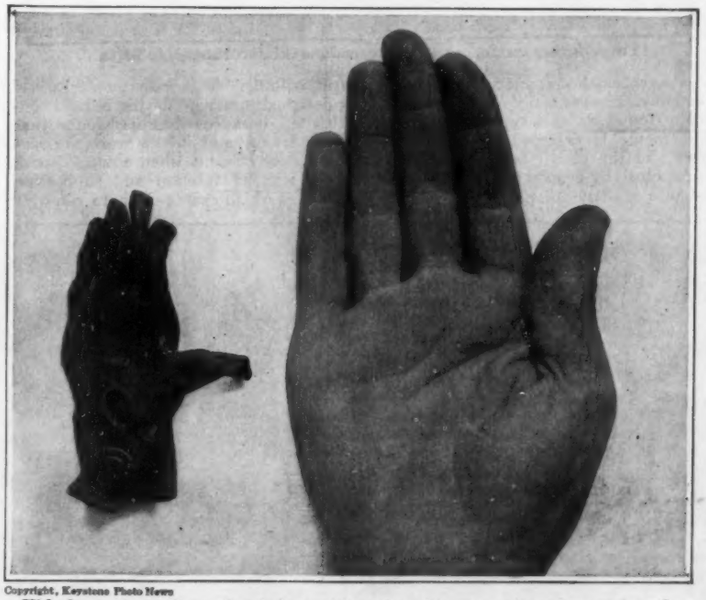
Tank for repairing and testing German U-boats

How Poison Gases Shrink Leather

TO the wearer of a leather coat, we have this to say: beware of being caught in a poison gas attack. That expensive leather overcoat which seems so impervious to rain may take on the appearance of a ten-dollar suit after a rainstorm, if exposed to the fumes of certain poisonous gases employed in the recent war.

A case in point is shown in the accompanying illustration. Following an intense bombardment of the French lines by German gas bombs, near the village of Belloy in the Oise district, the non-commissioned officer Alexandre Izarn, was taken to the hospital suffering from the gas. The following day he found in the pocket of his overcoat the kid glove shown, hardened, shrivelled, and reduced to a length of four inches and a width of less than two inches. His hand, photographed alongside the glove, gives the exact proportion in order that the degree of shrinkage can be ascertained at a glance. What has happened to this kid glove might well happen to other leather articles coming in contact with the particular gas employed by the Germans on that day.



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Kid glove of an officer after being subjected to German poisonous gases, and hand on which it was worn

Measuring Fluid Velocities with a Hot Wire

THE measurement of the velocity of currents of air and other gases is a field of applied science which has never been on a wholly satisfactory basis. With the Pitot tube and the tilting water gage it has been customary to measure the difference between the static and dynamic heads; and this difference is roughly proportional to the square of the velocity. But the technique of this test is one which cannot with any degree of confidence be entrusted to the hands of a workman unskilled in its execution; and in addition there is a grave question as to just how accurate the determinations are under certain circumstances.

An interesting suggestion which has been tried out recently with much success is that the velocity of a stream of gas be measured by observing the rapidity with which it cools a hot wire. The fundamental basis of this suggestion is obviously a sound one; the time which it takes the stream to bring the wire down from, let us say, 400 degrees to 300 is certainly a function of the velocity, among other things. If we can be sure of always having the gas at the proper density and temperature, so that the specific heats involved shall not fluctuate beyond our ability to keep track of them, and if we can regulate with some measure of security all the other variables of the experiment, leaving only the velocity free, we shall have an effective means of determining the latter.

Plating Iron with Copper Automatically

PLATING iron with copper has received much attention from practical and scientific men; but aside from the deposit secured by immersion of iron in copper salts, by electroplating, or by welding together thin sheets of iron and copper, these efforts have met with no success, says an American metallurgical authority. Failure of mechanical plating has been due to the fact that the conditions normally and necessarily present in the plating operation are antagonistic to the production of copper-plated iron. In most, if not quite all of them, a bath of molten copper has been used. The temperature of a molten copper bath is so high that the iron oxidizes before it can be immersed in the molten copper; unless a protective flux for the molten copper is used its surface will also become oxidized; and, in any event, the plated iron will oxidize immediately on its being withdrawn from the molten bath.

A company at Elizabeth, N. J., is plating iron sheets with copper by a new process. The plating metal is applied to the sheet in the form of a soft mixture by means of rolls, such as inking rolls. The sheet, after being coated with this mixture, is automatically carried forward and deposited on a link-belt conveyor, which carries it through a furnace maintained at a temperature well above that of molten copper. The basic principle involved in this method lies in the application of the plating metal to the sheet while the sheet is cold and then melting the metal in place on the sheet under conditions which are favorable to the formation of the plating.

Ash Removal By Suction

WHAT is virtually a large sized vacuum cleaner has been delivered to a concern in New York City that specializes in cleaning ash bins of public buildings and large residences and while the apparatus is experimental because it is now being tested out, the designers feel sure it will prove to be not only practical and efficient, but will meet with the approval of the general public by minimizing the discomforts and dirt now met with in ash removal by the usual means of dumping the filled galvanized iron containers into open cart bodies.

The equipment is mounted on a five-ton chassis and is a large box compartment, resembling the conventional van, the doors and gates of which can be closed tightly. On the chassis is mounted a blower that is driven by the engine, and this is so adapted that ashes are drawn into the compartment from the ash pit, no matter what the angle, through a telescoping metal tube. The truck is driven to the curb at the nearest point to the ash pit and the tube is extended into it. The ashes must be shoveled to the lower end of the tube and the suction carries them into the compartment on the truck.

The labor is limited to shoveling into the ash pit, or at least handling so the ashes can be drawn out by the blower, and there is no dust blown about outside. The time of loading the truck is much more rapid than would be possible were the work done manually, and this is of material importance when the time of trucks is considered as representing a substantial value. The prevention of dust will be approved by all sanitary departments of municipalities. The work of the apparatus is so satisfactory that adoption will soon be general, both for municipalities and for contractors.

The Motor-Driven Commercial Vehicle

Conducted by MAJOR VICTOR W. PAGÉ, M. S. A. E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles

The mobile restaurant belonging to the New York Police Department

Travelling Restaurant for Police

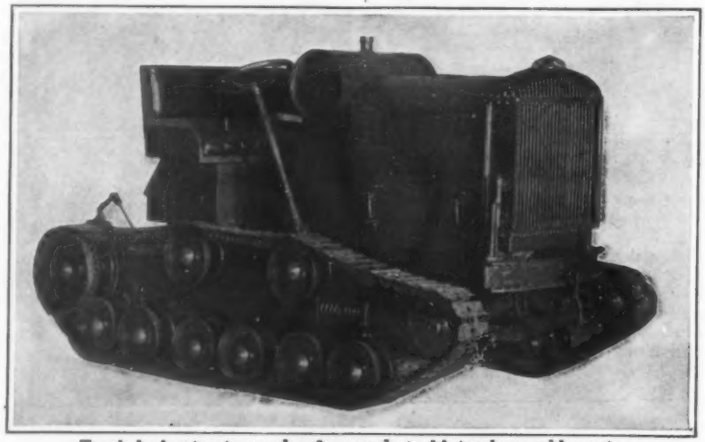
THE work of the police during large celebrations is marked by actual physical discomfort because of the long period of duty without any opportunity of receiving refreshments; it is not possible for them to secure relief or leave their post because all available men are utilized at such times.

A feature of a recent military parade in New York was the appearance of the police department's new travelling restaurant, which preceded the parade by over an hour and distributed sandwiches, coffee and apples to the wounded soldiers and to police officers on duty along the street. The truck worked from 6.30 A. M. until late at night, under the direction of a lieutenant and five policemen, and distributed 18,000 sandwiches. The appearance of this restaurant truck was due entirely to the generosity of Deputy Police Commissioner John A. Harriss, who not only donated the refreshments, but presented the truck to the police department as well. Dr. Harriss has always been keenly alive to the discomfort suffered by patrolmen under holiday conditions and during severe weather, when their regular hours are considerably lengthened and their meals few and far between.

With a view of bettering these conditions he ordered a three-ton truck, upon which chassis was mounted a complete lunch wagon—body 21 feet long and 7 feet wide. This is completely equipped as a travelling restaurant, as the accompanying illustrations show, having a coffee machine and pantries that insure warm meals under all conditions. There are 20 seats inside and in cold weather the interior may be heated by radiators connected with the exhaust manifold.

New Track-Laying Tractor

A NEW and self-laying track type of farm tractor designed by C. H. Martin of Springfield, Mass., is shown in the accompanying illustration and is interesting because it incorporates novel features of construction. The tractor is the outcome of experimental work which the inventor did, in coöperation with the Ordnance Department at Washington, D. C. The tread is made entirely of pressed steel, which means light weight and great strength and that material is also used liberally in the construction of the track supporting rollers, track drive sprockets, etc. The design admits of the use of the conventional motor truck construction and eliminates many of the crudities usually found on this type of machine. The tractor is designed to pull three plows and the design permits of ready manufacture by economical and progressive auto construction principles.

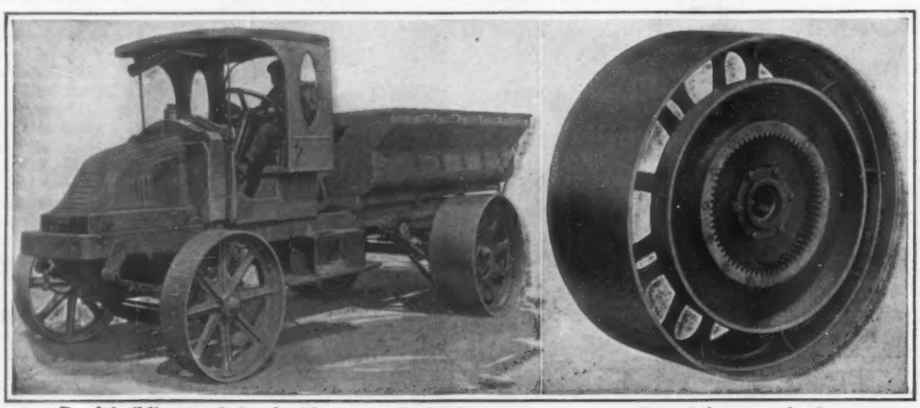


Track-laying tractor made of pressed steel interchangeable parts

Steel Wheels for Truck Conversion

CONVERTING the standard automobile truck into an efficient combination road roller and motor truck has become entirely practical with the introduction of a special cast steel wheel equipment for motor trucks engaged in road building. This wide rim steel wheel is designed primarily for use in road construction, because it has been found that motor trucks used in this work are rendered more efficient when equipped with broad rimmed traction and supporting members which enable them to run over the soft ground, sand, gravel, and crushed stone surfaces encountered in building roads, without sinking in.

The motor truck thus equipped does double duty, adding a substantial effort toward the finished job every time it hauls a load of material. The constant passage of a heavy motor vehicle loaded with road building material (a five-ton truck with a capacity load weighs approximately 10 tons) assists in firmly packing the newly laid road bed. This steel road building wheel for motor trucks, is built for any make of final drive, chain, internal gear or worm, and is easily and quickly interchangeable with ordinary motor truck wheels. Truck manufacturers are offering these wheels as standard equipment on trucks which are to be used in "good roads" construction, and as extra equipment to contractors who require service of their trucks in several different lines of work. The accompanying photographs will give a good idea of the appearance of a standard truck with the new wheels attached in place of the conventional rubber tired members.



Road-building truck fitted with cast steel wheels **One of the rear wheels**

Why War Trucks Will Not Flood the Market

MOST trucks used for the transportation of men and materials abroad during the war will not find their way back into the market, reports a former member of the 102d Engineers, recently returned from France. There are two main reasons why this is so. One is that the transportation problem is equally as difficult now as it was when the war was reaching its climax. The other is that the trucks have been subjected to such hard usage that they are junk when discarded. When units employing trucks are broken up and returned home all motor transports are turned over to a base or depot. Those that can be repaired are overhauled and kept in service by being assigned to active units, but many trucks are scrapped without even being taken to a salvage dump because their restoration is not considered worth while.

These worn-out trucks will have to be replaced by new trucks and it is doubtful

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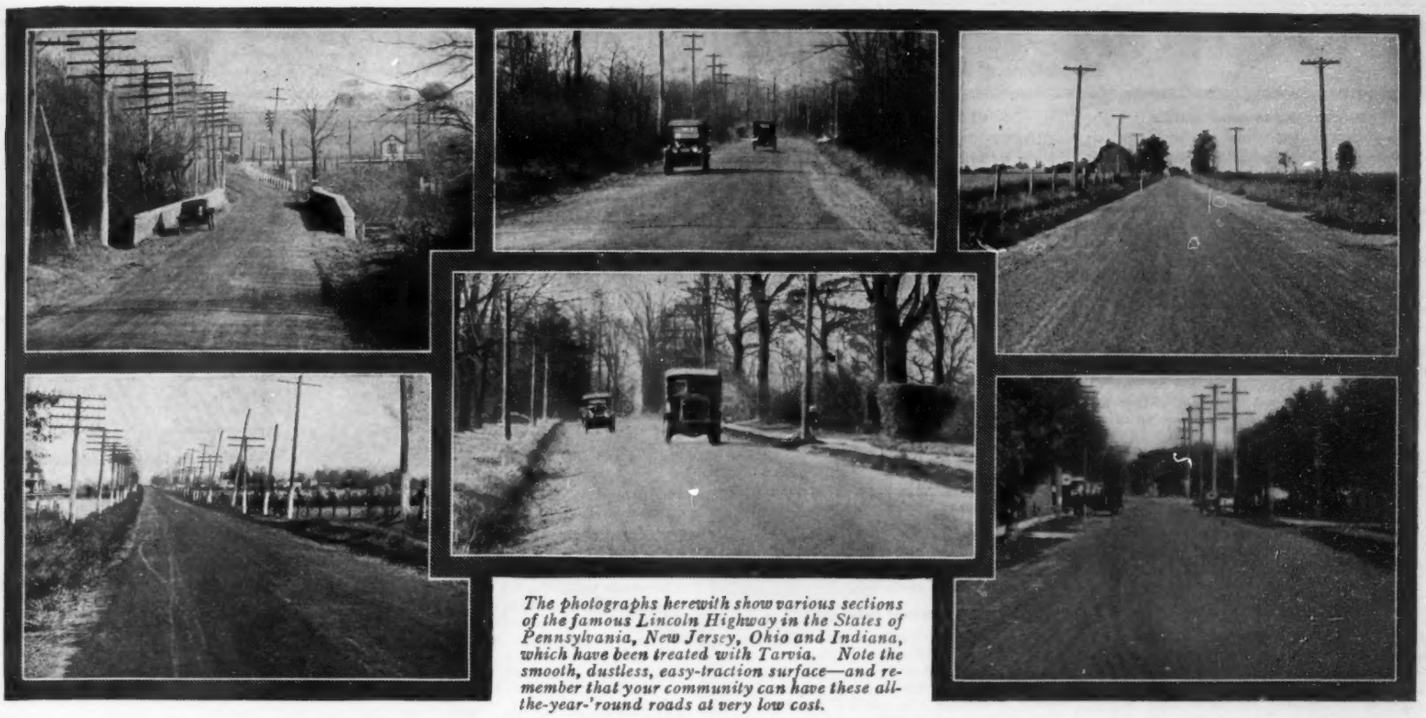


The photographs herewith show various sections of the famous Lincoln Highway in the States of Pennsylvania, New Jersey, Ohio and Indiana, which have been treated with Tarvia. Note the smooth, dustless, easy-traction surface—and remember that your community can have these all-the-year-'round roads at very low cost.

Good highways should be continuous!

We should have continuous highways available the year 'round.

Traffic should continue to operate in winter as well as in summer.

Economic development demands this.

Mr. Roy O. Chapin, Chairman of the Highways Transport Committee, says:

> "These main highways must be brought into a comprehensive system—patterned as the railroads have patterned their systems, striving to connect population and shipping centers with regions of natural resources — agricultural, mineral, etc. Permanent surfaced highways must be *built* and maintained sufficient to withstand the strain, and carry the traffic of the future."

Of what use to National highways transportation are certain good sections of road, if some communities persist in their neglect to improve and properly maintain the connecting links?

The facilities for motor car and truck transportation are already far ahead of the roads. This neglect of road improvement, therefore, is putting obstacles in the path of rapid national economic development.

The one economical method of making and maintaining highways is Tarvia-macadam construction.

Plain water-bound macadam is no longer strong enough for heavy-traffic highways, but Tarvia-macadam will stand the wear and tear of speeding automobiles and giant motor trucks.

The initial cost of a Tarvia road is a little more than that of ordinary water-bound macadam, but the great saving on maintenance more than offsets the difference in first cost. Indeed, many communities are now using Tarvia on all their principal roads *to save money.*

Communities that already have plain macadam roads that are beginning to show wear will find that a prompt surface application of the appropriate grade of Tarvia will arrest their deterioration and greatly prolong their life, and at much less expense than by any other method.

Special Service Department

In order to bring the facts before taxpayers as well as road authorities, The Barrett Company has organized a Special Service Department which keeps up to the minute on all road problems.

If you will write to the nearest office regarding road conditions or problems in your vicinity, the matter will have the prompt attention of experienced engineers. This service is free for the asking. If you want *better roads* and *lower taxes,* this Department can greatly assist you.

Tarvia

Preserves Roads—Prevents Dust

New York, Cleveland, Birmingham, Seattle, Youngstown, Chicago, Cincinnati, Kansas City, Peoria, Toledo, Philadelphia, Pittsburgh, Minneapolis, Atlanta, Columbus, Duluth, Richmond, Milwaukee, Latrobe, Dallas, Bangor, Bethlehem, Boston, Detroit, Nashville, Washington, Elizabeth, St. Louis, New Orleans, Salt Lake City, Johnstown, Buffalo, Baltimore, Lebanon

THE BARRETT COMPANY, Limited: Montreal, Toronto, Winnipeg, Vancouver, St. John, N.B., Halifax, N.S., Sydney, N.S.

The Barrett Company

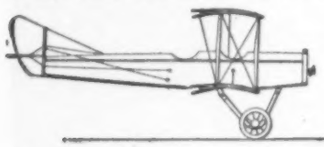
Recently Patented Inventions

Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Aeronautics

INCLINOMETER FOR AIRPLANES.—G. W. FARTHING, 537 Patton St., Dry Fork, Va. Among the objects of this invention is to provide an inclinometer adapted to be mounted in the hood or cowl of an airplane, the inclinometer including a plumb ring pivotally mounted and adapted to always remain stationary, the deflection between a pointer carried by the plumb ring and a corresponding pointer back of the ring, indicating the amount of lateral deviation of the planes from the horizontal.

AIRPLANE.—P. C. SHERNER, 122 Second St., Ogden, Utah. The object of the invention is to utilize as an assistance in the propulsion as well as stability of the machine, certain air currents developed in its normal operation. More particularly the invention aims to provide an adjust-



A VERTICAL TRANSVERSE SECTION SHOWING INVENTION APPLIED

able wind vane in connection with an airplane wing, and adjustable at a point where the air current directed forwardly over the rear extremity of the wing will engage the vane and assist in the propulsion of the machine and the stability thereof, without increasing the normal wind resistance.

INCLINATION INDICATOR.—W. H. NELSON, Norwood, Colo. The object of the invention is to provide a device designed for use with flying machines to indicate the inclination of the machine both in axial and transverse directions in regard to the line of flight. The indicator com-

SIDE VIEW OF AIRPLANE SHOWING INDICATOR

prises an annular hollow transparent ring having partitions located at diametrically opposite points and dividing the interior of the ring into two compartments, a ball mounted to roll in each compartment, and a scale in connection with the ring for indicating the position of each ball.

Pertaining to Apparel

GARMENT HANGER.—H. E. WILLIAMS, 120 Broad St., Red Bank, N. J. The object of this invention is to provide a hook for hanging garments, for holding separately a hat, coat and

VIEW OF THE DEVICE IN POSITION

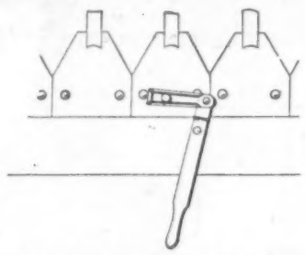
trousers, and thereby capable of economizing closet room. The hook is provided with means for hanging the trousers so as to preserve the crease, thus dispensing with a separate hanger for this purpose.

Electrical Devices

RECEIVING INSTRUMENT FOR WIRELESS SIGNALING.—A. ARTOM, Turin, Italy. This invention consists in receiving appliances or devices for wireless signaling or the like, wherein the movable coils are traversed not by oscillatory, but by rectified currents from the directive aerial conductors of a station designed for receiving signals from several directions. The magnetic action on the movable coils is produced by a powerful permanent magnet or electro-magnet. The coils are disposed vertically and are free to turn around a vertical axis.

Of Interest to Farmers

SICKLE PULLER.—S. D. RUSSELL, care Odessa Farm, Winfield, Kans. The object of this invention is to provide a device of the character specified especially adapted for removing the sickles from mowing machines and for replac-



A TOP PLAN VIEW OF A PORTION OF SICKLE BAR SHOWING TOOL IN USE

ing them, wherein means is provided for permitting the removal or replacement of the sickle without the necessity of handling the same and from the rear of the sickle bar.

Of General Interest

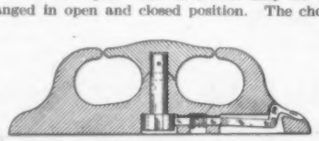
DOUBLE-EXPOSURE PREVENTER.—W. H. TOUCHETTE, address F. R. Clement, 194 S. Prospect St., Burlington, Vt. The invention relates to film cameras and has for its general objects to provide a simple and reliable device which is so designed that when the shutter is operated a locking means is brought into operative position for preventing a second operation of the shutter, controlling means in case the operator should forget to move the film for the next picture. Another object is to provide a locking device which is automatically reset as soon as the film is moved.

MILLINERY DISPLAY DEVICE.—H. STEARNS, 656 Broadway, New York, N. Y. The invention has particular reference to means for displaying hat trimmings, such as feathers or the like. Among the objects of the invention is to provide a holder which may partake of the character of a box or analogous receptacle to constitute a covering or closure means for the commodities, the said holder being provided with means for suitably holding individual millinery units, and also to produce the best possible display.

CATCH FOR BELTS.—S. B. GIRDLER, care Simmons Hardware Co., St. Louis, Mo. Among the objects of the invention is to provide a quick acting catch which will not readily become disengaged accidentally, and to provide a catch which is extremely strong both in general make-up and in its resistance to any opening action produced by the usual pull thereon, yet may be quickly released when desired.

FIRE EXTINGUISHER.—D. E. MUIR, 1338 Franklin Ave., Bronx, N. Y. The object of the invention is to provide a receptacle disposed within an outer receptacle and containing an expelling fluid under pressure. The expelling fluid is retained in the inner receptacle and flows to the space between the inner and outer receptacles to the outlet in the outer receptacle. A further object is to provide a fire extinguisher from which may be discharged a portion of its contents without endangering the operativeness of the extinguisher at a considerable period thereafter.

BOAT CHOCK.—P. G. JOHNSON, care Anderson and Setters, Attnys, Astoria, Ore. The object of this invention is to provide a boat chock which is adapted to facilitate the insertion and removal of ropes. The invention may be arranged in open and closed position. The chock



A LONGITUDINAL VERTICAL SECTION OF CHOCK

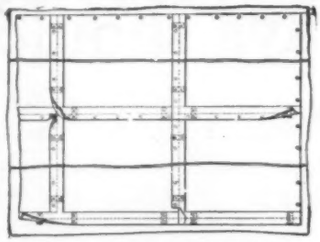
consists of a casting comprising upwardly projecting, inwardly curved arms, located at the opposite ends of the chock and spaced apart. Between the opposed extremities of these arms is a member rotatable on a vertical axis, having laterally projecting arms; means is provided for locking the rotatable member in place.

PROCESS OF MAKING ARTIFICIAL DENTURES AND OCCLUDING FORM FOR THE SAME.—O. E. WALL, Box 648, Honolulu, Territory of Hawaii. An object of the invention is to provide a process by means of which artifical teeth may be set in dental plates, so as to effect the proper occlusion in much less time, and with greater accuracy than by the ordinary steps. A further object is to provide what may be termed an "occluding form" by means of which the teeth are readily secured in position, so that when the form is removed substantially perfect occlusion will be insured.

SPOOL HOLDING APPARATUS FOR FACTORY MACHINES.—S. BERKOVITZ, 330 E. 60th St., New York, N. Y. Among the principal objects which the invention has in view are to prevent tampering with thread supplied to various mechanics in factories where thread is employed, to facilitate the keeping of stock accounts, and particularly of the stock of thread used in factories employing the same, and to prevent the purloining of thread by mechanics using the same.

METALLURGICAL PROCESS.—C. M. MALSCH and C. H. GILSON, address Sociedad Metalurjica Chilena Cuprum, Valparaiso, Chili. The invention relates to the extraction of metal from ores, particularly sulfid ores. An object is to provide a method which permits the reclamation of metals from poor ores. Another object is to provide a process in which the ore, in the process of oxidation is converted into soluble salts which can be easily precipitated from the solvent.

WATERPROOF SEAM FOR COMPOSITION BOARD.—A. G. PAFFENBARGER, 512 Woodward Ave., Portland, Ore. This invention relates to a waterproof joint for composition and other boards whereby the same can be used for



PLAN VIEW OF PORTION OF ROOF WITH WATERPROOF JOINT EMPLOYED

roofs, walls and other exterior work, the principal object is to provide an overlapping flexible seam joiner of simple and inexpensive construction and so designed that the boards can be easily and quickly laid and the watertight joint secured.

Machines and Mechanical Devices

ROLLER BEARINGS.—W. D. BURNS, Amenia, N. Y. The general object of the invention is to provide a bearing, the rollers being arranged in two annular series, the respective rollers of which are in staggered relation and present overlapping end surfaces; the rollers are reduced at one end to present spindles on which spacing rollers turn; the arrangement serves to reduce the tendency of the axle to wedge between the rollers and spread them apart, and, also, sliding friction between the rollers is eliminated.

SWIVEL JOINT.—D. O'BRIEN, De Quincy, La. This invention relates more particularly to a means to form a swivel joint so that the pipe may be turned about its axis. The general object is provide a swivel joint whereby a fluid-tight connection is insured and the packing of the joint may be renewed when desired by the removal of a gland or packing nut without disturbing the remainder of the joint elements.

Prime Movers and Their Accessories

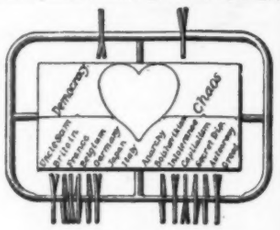
SKELETON ADJUSTABLE PISTON.—G. MCCADDEN, care MCCADDEN Works Co., St. Cloud, Minn. The invention relates generally to pistons for explosive engines, and more particularly to a lightweight piston of skeleton formation and adjustable in order to compensate for wear, the object being the provision of an inexpensive construction whereby a piston of the above general type may be produced.

Railways and Their Accessories

BRAKE HANGER.—L. E. KEIL, St. Louis Car Co., St. Louis, Mo. The invention relates to the brake mechanism of railway car trucks; its object is to provide a brake hanger arranged to keep the brake shoes at all times in exact alinement with the car wheels to prevent uneven wear of the brake shoes. Another object is to prevent rattling and chattering in an up and down direction when the brakes are applied.

Pertaining to Recreation

PUZZLE.—F. A. MCCABE, Blackfoot, Mont. The invention relates to a simple and inexpensive puzzle. The object of the invention is the provision of a puzzle consisting of an apparatus which



A PLAN VIEW OF THE PUZZLE

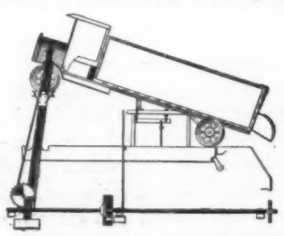
may be readily carried upon the person, without inconvenience, and the solution of which may proceed from time to time, for instance, at spaced intervals, without endangering the loss at any time of previous efforts to this end.

Pertaining to Vehicles

VEHICLE SEAT ATTACHMENT.—W. A. DELONG Jr., 1 Madison Ave., Plainfield, N. J. Among the principal objects which the invention has in view are to adapt the seats of an automobile, and particularly the rear seat of a tonneau, to be quickly changed for use by one person, and to provide a structure with adjustable arm and shoulder rests for supporting passengers in desired riding position. The device comprises movable supports for dividing the seating space of a cushion, and means for locking the supports in adjusted position.

BRAKE BAND.—E. J. LEE and E. H. STEINMETZ, Bangor, Pa. The invention relates more particularly to emergency brake bands of Ford automobiles. An object is to provide a device which will insure the uniform expansion of both ends of the brake band when the latter are actuated by the cam, so that both ends of the brake band will engage the drum. A further object is to provide means for expanding the uniformly without detracting from the efficiency of the brake band as a whole.

AUTO TRUCK DUMP.—P. HEDSTEOM, 230 Boston Bldg., Minneapolis, Minn. The invention has for its object to provide a device for use in connection with dump weighing scales for lifting the front end of a motor truck to dump the load



A SIDE VIEW WITH PARTS IN SECTION

through the rear end, and so arranged that the lifting mechanism will not interfere with the proper weighing of the load, that is, to lift the front wheels of the truck while it is on the dump, with the dump in horizontal position.

Designs

DESIGN FOR A HAND BAG FRAME.—G. MONTRONI, 102 Fulton St., New York, N. Y.

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject-matter involved, or of the specialized, technical or scientific knowledge required therefor.

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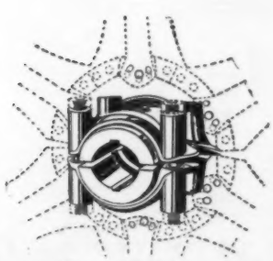
The New Keystone Steel Pulley

The grooveless, oval crown of Keystone Steel Pulleys presents a smooth, uninterrupted surface to which belt *naturally* conforms. The Keystone, therefore, transmits power at low belt tension.

Keystone rivets never shear. Whenever rivets are used in Keystone Steel Pulleys, the metals are countersunk. This protects the rivets from all shearing strain.



The arms and hub of Keystone Pulleys are interwoven. Great strength is necessary at this point as the arms act as levers from rim to hub. The stress at the hub is from four to twelve times as great as that at the rim. Keystone hubs are amply strong to resist this strain.

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The Arms—Extra strong and wind cutting, offer minimum air resistance.

The Hub—Interwoven with the arms affording the greatest possible strength. All sizes over 16″ diameter reinforced by malleable iron yokes. The new Keystone, when properly tightened, will not slip on the shaft.

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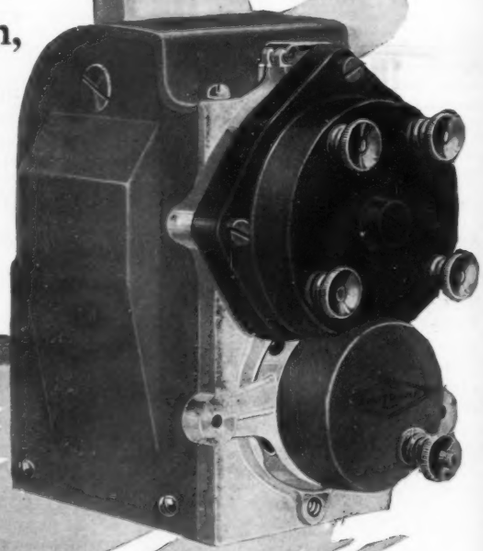

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The Friendly War After the War

(Continued from page 652)

and otherwise acting as orthodox advertising agent. It is worth noting, by the way, that those in whose hands has been placed the actual workings of the Industrial Publicity Service were selected with unusual care. They are all men of big caliber and are paid in proportion.

The supreme importance of an adequate foreign press service, as viewed by the Federation, is set forth in a report submitted by its Overseas Main Committee, dated March 5th of this year. Among other things, the report states:

"Your Committee urge that propaganda and publicity matter are of special urgency at the present juncture for the following reasons:

"(1) The closing down of the British Ministry of Information at a time when the governments of other countries, allied and neutral, have embarked on an intensified propaganda in overseas markets.

"(2) The great activity of foreign and publicity agents.

"(3) The general lack of intelligent or adequate propaganda on behalf of British industry and commerce in the press of foreign markets, even when that press is substantially or mainly supported by revenue from the advertisements of British firms."

The man retained to control the foreign press propaganda is peculiarly well fitted for his task, having been for many years at the head of one of the largest advertising agencies in Great Britain. His staff is being actively recruited, and the preparation of live news matter is at present in full swing.

It is felt by the Federation that eventually the funds accruing from the Publicity Service, in its capacity as advertising agent, will amply maintain its press service, and that these funds are more likely to increase than to diminish with the passing of the years.

Viewed by and large, in confining its definite action mainly to the sphere of publicity in its various forms, the Federation seems to have taken the only course that is both practical and impartial. Directly to subsidize, or in any other way to foster, the interests of any one industry or group of industries, could not redound to the advantage of British industry as a whole.

It is quite clear that the Federation, the most powerful trade organization Great Britain has ever known, is prepared to fight to a finish for every market open to civilization. The Federation's methods in some cases have been anticipated and successfully carried out in America by the National Association of Manufacturers. In other cases the chief departure from precedent is in the comprehensiveness and thoroughness of the measures taken. At any rate, American manufacturers, who are not accustomed to shrink from competition unless it be fostered by government subsidy or be otherwise unfair, need not hesitate to take up the gauntlet. It is as nearly certain as anything in the future can be that the two great English-speaking peoples are destined to hold their dominance in the world's work, and that the western hemisphere will earn its full share of the fruits of this work.

Monetary Cost of the War

(Continued from page 647)

on each side. The debt of Great Britain now amounts to 36 billion dollars, of which 33 billion was incurred during the war. Thirty-six billion dollars' worth of gold would make a cube measuring 52.3 feet on a side. The debt of France is also 36 billion dollars; while Italy's debt is about 12.6 billion dollars, which would make a cube measuring 36.9 feet on a side. The gross debt of Germany is estimated at 39 billion dollars, which would make a cube measuring 53.7 feet on a side. If we pile these cubes one above the other, they would make a golden tower 254 feet high or but little short of the height of Trinity Steeple in New York, which rises 284 feet from the ground.

Standing beside this tower of debt, we have shown a block of gold measuring 43.8 feet on a side which represents 20 billion dollars, or an estimated total of the supply of gold in the world. Of course, the real significance of a debt is not measured by its total, but by the per capita burden and its relation to the income per capita of the nation. For this reason we have shown a conventional figure representing a citizen in each of the five countries involved. The wealth of the United States is estimated at 300 billion dollars and dividing this among a population of 107 million we have a per capita wealth of $2,803. The debt of 30 billion dollars divided among the same population represents a burden of $280 on each individual, and so the conventional figure of the American citizen is shown with a bucket which if full would hold $2,803, but which has been emptied to the extent of $280, while in the bottom of the bucket there is a leak from which is dripping $11.68 representing the per capita interest on our national debt.

Great Britain is somewhat in the same condition as the United States in the fact that a certain portion of her debt, about 5 billion dollars, will be paid back by her allies and dominions so that eventually her debt of 36 billion dollars should be reduced to 31 billion dollars, but as this has not yet been repaid we have retained the total debt of 36 billion dollars in our estimate of her per capita indebtedness. The per capita wealth of Great Britain is $2,608 and her debt per capita $782, and the interest on the debt, per capita comes to $34.24.

France with the same debt as that of Great Britain has a much bigger load to carry because her wealth is not so great and her population is smaller. In estimating the wealth of France the calculation is complicated because France suffered heavy losses of property in the war. On the other hand Alsace-Lorraine has been added to France and the wealth and income of these provinces must enter into the calculation. Taking all these factors into consideration, the national wealth of France is placed at 90 billion dollars so that her per capita wealth is estimated at $2,250 with a per capita debt of $900 and with interest on the debt of $45. The burden of France, therefore, is exceedingly heavy.

Italy has a debt of only 12.6 billion dollars, but her per capita wealth is only $1,111 and her debt is $350 per capita with interest charges of $15.22.

Germany has a per capita wealth of $1,231 with a debt per capita of $600 and interest charges of $30. This, of course, does not include the indemnities which Germany will have to pay and which in turn will lighten the burdens of the other nations.

The situation is tabulated by Mr. Fisk as follows, the figures for United States having been amended by us as explained above:

DEBT AND INTEREST CHARGE COMPARED WITH ESTIMATED WEALTH AND INCOME OF THE PRINCIPAL BELLIGERENTS IN THE LATE WAR

Nation	Debt	Wealth	Debt % Wealth	Interest	Income	Interest % Income
United States.	$30	$300	10.00	$1.250	$60.0	2.08
Great Britain.	36	120	30.00	1.575	15.5	10.16
France.....	36	90	40.00	1.800	12.0	15.00
Italy.....	12.6	40	31.50	.548	7.5	7.30
Germany.....	39	80	45.75	1.950	10.0	19.50

(Debt, wealth, interest and income in billions.)

DEBTS AND INTEREST CHARGE COMPARED WITH ESTIMATED WEALTH AND INCOME OF THE PRINCIPAL BELLIGERENTS IN THE LATE WAR PER CAPITA BASIS

Population (In millions)	Nation	Debt Per Capita	Wealth Per Capita	Interest Per Capita	Income per Capita
107	United States...	$280.	$2803.	$11.68	$560.
46	Great Britain...	782.	2608.	34.24	337.
40	France.....	900.	2250.	45.00	300.
36	Italy.....	350.	1111.	15.22	208.
65	Germany.....	600.	1231.	30.00	154.

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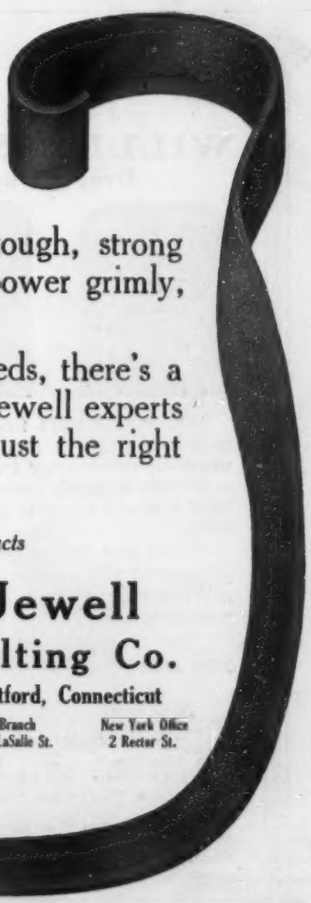
Our process of making hides into leather belting depends as fully on hand skill and experienced judgment as on machine work. This personal element in manufacture is what gives our belting its better quality. From tanning to inspection, the watchfulness and care of our workmen never stops. This accounts for the unusual wear and service of

Jewell Belting



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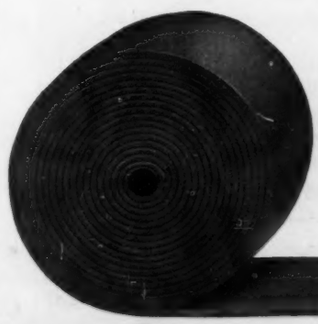

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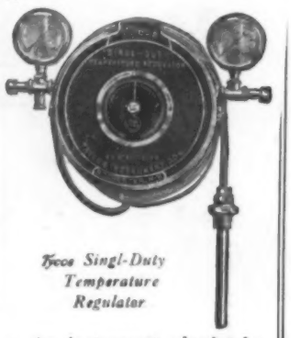

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Science in the War

(Continued from page 653)

in 24 hours as much as it ordinarily hardens in a week.

The work of the Bureau in metallurgy can be but mentioned, important as it was. The Bureau has a complete metals investigating plant, including foundry and rolling mill. Before it took up the work there was no institution here devoted to development of new metals, although Germany had one institute which did nothing else. The new light weight metals developed by the Bureau, alloys of aluminum, magnesium, copper, etc., have had many applications in the arts of war, and must have as many if not more in the development of the arts of peace.

It would be very easy to continue this account through an almost indefinite amount of space. For instance, in summarizing the war work of the Bureau of Standards in the realm of electricity, it is found that the investigations included those in electromotive force, resistance, current inductance, capacity, conductivity, insulation, magnetic permeability and hysteresis, radio-activity and radio-communication, including researches on electrical units and standards and measuring instruments and method of measurement. In light and optical instruments the Bureau conducted, for war purposes, researches in the development and improvement of photographic plates, color measurements and specifications of color standards, color transmission of dyes and other materials, precise measurement by the use of interference fringes, design and testing of optical instruments and systems, measurement of luminous and subluminous radiations and the light transmitting and reflecting properties of various substances, dispersion of light, the development of new lenses for special cameras—it is a catalog almost without end.

But the best of the story remains to be told. The investigations made to further the cause of war have almost invariably an even larger application to peace. What has been discovered to be the best insulating material for airplane spark plugs is the best known for automobile motors. The directional wireless investigation may revolutionize modern wireless communications. The metals, materials and glass developed for the conduct of war must necessarily have a great influence on manufacturing for peace purposes. So that, while it is true that much otherwise necessary work at the great scientific research institution of the government was unavoidably shelved in order that all its trained staff and magnificent equipment might be turned to the problem of winning the war, it is also true that the knowledge thus gained and either now or eventually to be made public, will be of the greatest benefit, not only to the United States, but to the world at large.

The American Precision Block

(Continued from page 658)

what amounted to a challenge. It was necessary for it to develop some means of measuring through interference fringes, not necessarily more accurate than the method of the interferometer, which deals with millionths of an inch, but certainly far more rapid and far more nearly self-operative and vastly cheaper to carry out. The successful response which was made to this demand will be the subject of another article in an early issue of the SCIENTIFIC AMERICAN.

Meanwhile, it is in order to ask just what significance Major Hoke's invention possesses. Perhaps the greatest significance is that it has forced the adoption of the wave-length as the measuring element. At present the standard yard is defined as the length between two marks on a certain metal rod, at a certain temperature. This is not ideal, for several reasons.

In the first place, why should one have to go to Washington or Paris to get a standard length? Of course, if one has not got precision equipment, one s willing to do this; but what if one has that equipment? Would it not be more rational to define the yard, the meter, etc., in terms of something that could be reproduced independently, anywhere? Would it not be a good idea at the same time to seek a standard that had no relation to temperature? It surely would; and the whole procedure in the Hoke case fairly thrusts such a standard upon our attention.

Why should we not define the yard and the meter as so many wave-lengths of such a particular light? Not light of such-and-such a color, of course, for that would be ambiguous; but light from such-and-such a source. For testing Hoke gages cadmium light has been found to possess several notable advantages. And Major Hoke looks forward to the day when the standard of length will be defined as "so many wave-lengths of such-and-such a light"—cadmium perhaps, or something else if anything better can be found.

Another point is this. The standard yardstick is not itself a yard long; it defines the yard as the distance between two marks which it bears. These marks are microscopic, to be sure, and therefore of slight thickness; but they do not lack thickness altogether. In comparing this standard yard with something else, and taking the other length away for use, one has to have a line on the secondary rod, and match up these lines as well as he can. In other words, the standard of length is arrived at by line measurement, which is inaccurate. One cannot match up exactly two lines, however fine they may be, and however nearly the same thickness. There is bound to be some error, which may be as much as 40 microns (one micron equals 1/25,400 inch).

The Hoke system substitutes *end* measurement for this line measurement. This is inherently more accurate; two bars, wrung to a common base, can be compared for length, mechanically, with an error of at most 2½ microns, and by the use of interference methods, with an accuracy that goes far beyond this figure. So if his invention leads to the general replacement of the line measurement by the end measurement, in connection with lengths and thicknesses, Major Hoke will be well pleased.

The Present Status of Our Dye Industry

(Continued from page 660)

the moment is undecided to what form they shall take. What a pity more chemists and engineers do not enter politics! In such questions as these they could do such valuable work. The dye men have said that ten years of a fairly high tariff would make tariff thereafter unnecessary, but there are many who think no reasonable tariff can serve when we are really in competition with a country. The adoption of the English plan of license is urged. This plan provides that no dyes of other than British origin may be imported so long as that dye or one with which satisfactory substitutes may be prepared is available at a fair price. It is hoped that such a system of license will protect British manufacturers of dyes, encourage them to add to their lines as rapidly as the market will justify it and at the same time make it possible for the textile and other dye-using industries to import from anywhere they will such needed dyes as the home market can not supply even in the form of a suitable substitute.

Perhaps some one may contrive a combined plan that will answer all the requirements but in addition to licenses and tariffs it seems likely that we should permit rather extensive combinations of firms under suitable government control because of the complexity of the dye industry and the great variation of its products where the finished product of one plant is the starting point of another.

Of course the industry is worth having! Germany has surely found it so and it has

(Continued on page 670)

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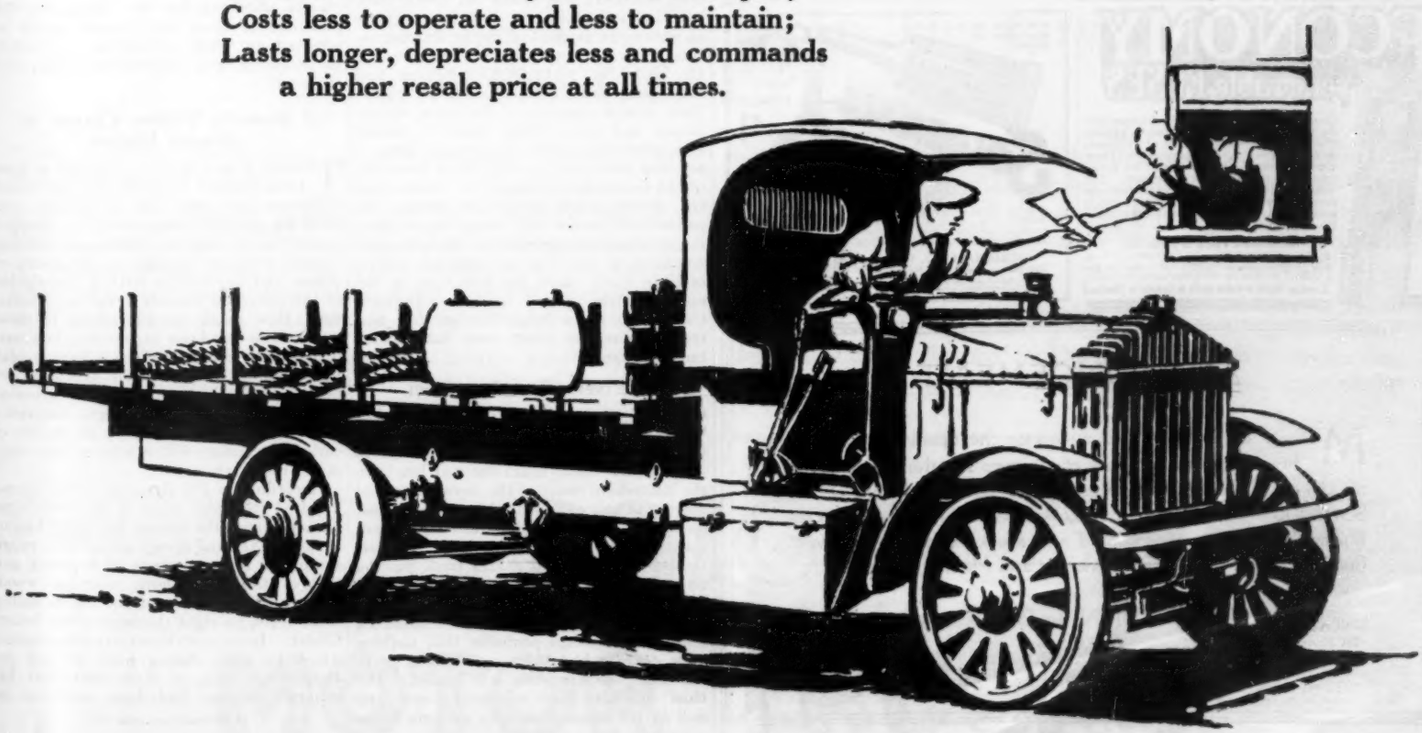

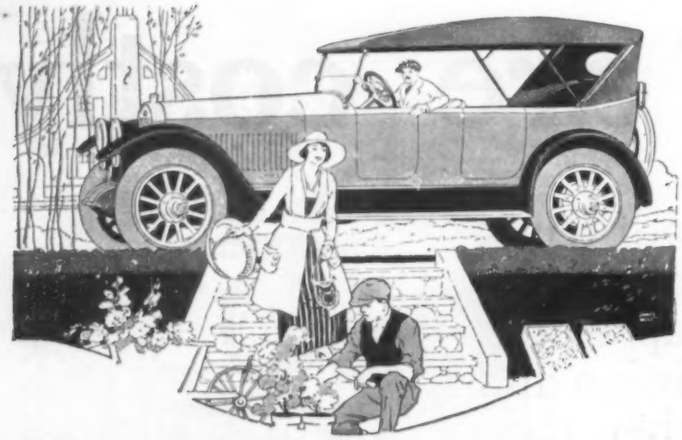

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The Present Status of Our Dye Industry

(*Continued from page 668*)

been said that the money invested in dye research in Germany has been the best investment in the world's history. It is the second time colors have helped make a nation strong. The first instance in history goes back to the days of Tyre and Carthage when those walled cities owed their wealth and power to Tyrian purple, a dye stuff obtained from a small snail-like shell fish the identity of which has been established from the piles of shells remaining. The dye stuff itself has been duplicated synthetically and is a form of dibrom indigo inferior to that now made so successfully in Michigan. A dye industry will also strengthen us, but it is not full grown and needs our support. A foreigner being asked for his views on the subject once told the writer that he considered America's greatest fault the tendency to take the will for the deed. Knowing that we have the resources and ability to accomplish something we have decided to do we are a little inclined forthwith to call it done. There is that danger in the dye situation and while its present status is surely satisfactory and highly encouraging there remains much that the public itself must do if we are to make it strong enough to endure.

Why War Trucks Will Not Flood the Market

(*Continued from page 662*)

if the number of trucks now contracted for will be sufficient to take care of present needs. The railroad system of France, even including the temporary military railways was and still is hopelessly inadequate, and motor transports were overloaded and driven at excessive rates of speed over roads that had been worn out by the abnormal traffic night and day or ruined by bombardment.

The cessation of hostilities has not relieved transportation difficulties. Troops must be fed and clothed, and the large movements of troops still taking place in France add to, rather than lessen, the demand for transportation. The feeding of the Central Empires and new states also adds greatly to the burden of transportation for they, as well as the Allies, are short of transportation.

Then the return of the refugees to the devastated regions where railroads have been destroyed and nearly all roads have been badly damaged by shell fire, requires an enormous amount of motor transportation. These people require supplies of all kinds, in addition to clothing and food, with which to rebuild or restore their ruined property. Factories, stores, homes and even farms must be rebuilt and until the entire war ruined area is restored there will be but little lessening of the tremendous demand for trucks, and the severe work performed during the restoration period will surely cause such depreciation that trucks that were in good condition at the close of hostilities will be of little value when the first rush of the reconstruction period is over. In fact, there will be a large market for new trucks to replace those worn out in such important service.

The New Zinconium Steel

STEEL containing zorconium promises to play an important role in the future metallurgy of the steel industry, says *la Genie Civil*. Here again the war has been the immediate cause of the development of the use of this element. Mystery, at least so far as published data are concerned, surrounds the results that have been attained in the United States from putting zirconium into various steels. There have been rumors in circulation about the striking properties its introduction bestows on steel, but it seems probable that nothing very definite had been ascertained up to the time the armistice was signed. The chief difficulty had evidently been, and still is, the production of a uniform ferrozirconium, one containing definite amounts of the metal and correspondingly regular amounts of other ingredients or the absence of them. It is apparently established that until raw materials are obtainable from which a dependable ferrozirconium can be made, definite or scientific progress is impossible.

Information from France, reveals the striking properties of French steel containing nickel and zirconium. A steel of medium carbon content and the usual nickel three per cent, but only 0.3 per cent of zirconium not only possesses a very high tensile strength and an elastic ratio of over 85 per cent, but also its toughness surpasses any other steel hitherto made. The surprising statement is made that this steel with a thickness of only 10 mm had afforded a better resistance to German perforating bullets than with the nickel-molybdenum or the chromium steels of greater thickness. The steel also has a Brinell hardness of 470 in high value.

Attention should be called, however, to the silicon and manganese contents of the steel referred to. These are high—one and a half and one per cent respectively. To what extent these two elements may be credited with bestowing the unusual properties we are not told. The value of both manganese and silicon is already appreciated. It is a high manganese content alone that has made possible the production of cast steel chain in this country having properties superior to any chain heretofore made. It is probable, however, that in the same manner that vanadium makes steel anti-fatigue, so zirconium increases to a remarkable degree the toughness.

Considerable concern is reported to exist as to the future supply of vanadium. It is said that present resources are being rapidly exhausted and that it may be necessary to find a substitute for vanadium. It is hoped that this may not be necessary for the value of vanadium has been eminently demonstrated. Should the rumors turn out to be true, it may develop that either zirconium or even titanium may take vanadium's place to a greater or less degree. Already the interest in titanium as an alloy in steel has been so active that unusual results are heard of as to its value as an alloy in steels.

It seems certain that we are on the eve of most interesting developments in the realm of alloy steels containing the rarer metals. It is probable that the interesting results obtaining by the British in the evolution of their tank armor should be credited to steels containing zirconium, molybdenum and perhaps vanadium and titanium.

A Recently Written Chapter of Remote History

THOSE of us who are old enough to have been brought up under the old school of history know well that the outlook upon early Egypt and Mesopotamia has changed greatly since the day when pre-Grecian history consisted mainly of the deeds of Ninus and Semiramis, with a description of the pyramids thrown in for good measure. How much our knowledge of these early times has been broadened, however, is perhaps seldom realized. In a recent talk before the National Academy of Science in Washington, Professor Breasted of the University of Chicago, America's foremost Egyptologist, gave an outline of early Nile history which is most illuminating in this connection.

According to Dr. Breasted, after several hundred thousand years of the discernible human career, the savage European hunter of the Ice Age had slowly advanced through successive improvements of weapons and tools of stone, bone, horn, ivory and wood, until the final retreat of the ice, probably some seven or eight thousand years before Christ. In spite of the remarkable progress which he made during what we call the Palaeolithic Age, it is evident that his general progress had been retarded as

(*Continued on page 372*)

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A Recently Written Chapter of Remote History

(*Continued from page 670*)

contrasted with his contemporaries on the south side of the Mediterranean in northern Africa. The retarding force was evidently the cold and ice of glacial Europe.

Unaffected by any such retarding obstacles the Stone Age hunters of the Sahara, then well-watered and fertile, were gradually able to shift from the Sahara plateau down into a great north and south rift in northeastern Africa, dating from Pleiocene times, which we now call Egypt. It was then a lake, but as the drainage of inner Africa found its way into this rift and through it into the Mediterranean, this long narrow, early Pleistocene lake became the lower Nile valley. As the alluvium began to collect on the bottom of the old lake, the Sahara hunters took possession of a fertile and sheltered valley, so generously supplied by nature and in climate so benign, that already in quaternary times, the Paleolithic Nile-dwellers outstripped Europe and left it far behind in the advance toward civilization.

While the Palaeolithic remains of the early Nile hunters are found in great quantities, especially in the form of stone weapons lying on the Sahara plateau above the river and along the surface as well as in the lacustrine and fluviatile terraces, the earliest stages of advance on the alluvium (earth deposited by rivers), the stages by which the northeast African hunters were transformed into settled communities, practicing agriculture and cattle-breeding, are buried deep under the upper alluvium which has accumulated since quaternary times. For the lower alluvium of the Nile valley was deposited far back in Pleistocene times, when Europe was still beset with the last descent of the ice.

In the earliest cemeteries and graves dug into the river terrace just outside the margin of the alluvium, we find the prehistoric Egyptians almost past the Neolithic stage and already in possession of the fundamentals which were steadily carrying him forward to the conquest of civilization, even in the centuries before 4000 B. C. The bodies found in these cemeteries, the oldest in the world, are so well preserved that the contents of the stomach and the alimentary tract can be examined. In practically all of them husks of barley are found, the oldest known cultivated grain. In pottery jars accompanying these burials, are found also wheat of the variety known as *emmer*, a kind of split wheat. This grain is a thousand years older than any found in Asia. As a result of recent discovery it is now evident also that the domestic cattle, sheep and goats possessed by the prehistoric Egyptians were of African origin, and were not introduced from Asia.

Having thus made the transition from the hunting to the agricultural and cattle-breeding stage long before 4000 B. C., the Egyptians discovered copper in the Peninsula of Sinai, probably about, or not long before 4000 B. C. The earliest of the prehistoric graves already contain copper needles with the head bent over in a hook to form the eye. These crude copper needles are the oldest known implements of metal wrought by man. The oldest copper mines in history, still survive in Sinai, accompanied by the most ancient historical monuments with which we are acquainted —monuments left by the earliest kings of Egypt to record their mining operations in the thirty-fourth century B. C.

As metal came into more common use, the Egyptians likewise evolved a system of writing, and on the basis of agriculture, cattle breeding, metallurgy and writing there arose a great state on the Nile, the earliest known organization of several million souls, which began about 3400 B. C. Having thus gained a stable and organized form of life, the Egyptians brought forth a highly developed civilization in the thousand years between 4000 and 3000 B. C.

Excavations in western Asia have not

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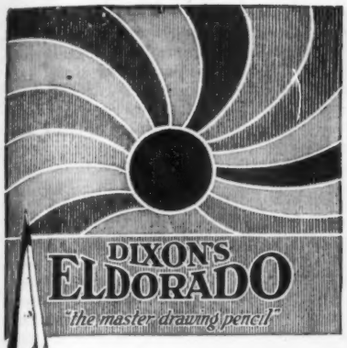

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yet disclosed the successive stages of prehistoric advance, as in Egypt. The development in Babylonia was evidently considerably later than on the Nile, and we cannot discern the situation there until just before 3000 B. C. But as Babylonia advanced, its culture was in close contact with that of the Nile. Already in prehistoric times, therefore, there had arisen a great culture nucleus embracing the contiguous regions of both continents—an Egypto-Babylonian group forming the earliest known civilized center, whence the earliest culture passed by diffusion to the neighboring regions. The earliest civilization in the eastern hemisphere thus arose and developed on both sides of the intercontinental bridge connecting African and Eurasia, just as in the western hemisphere it later arose on each side of the intercontinental bridge joining the two Americas.

Ornament in Old Prints and Drawings

By William M. Ivins, Jr.

IN the Exhibition of Ornament in the print galleries of The Metropolitan Museum of Art there are to be seen a number of most interesting examples of the manner in which the craftsmen of past times utilized the pattern engravings made by the old masters of design. Few of these designs show any particular care upon the part of the designer in regard to such matters as perspective or true proportions, and an even smaller number of them are measured or working drawings, but the craftsmen, nevertheless, knew how to translate them into the terms of the particular thing they were making, such as the same tune may be interpreted by the voice or by many instruments. As an instance of this, may be taken the series of plates by such great artists as Ranson and Lalonde showing wreaths and bunches of flowers and ribbons combined in the most charming and beautiful designs—the engravings so delicate in line that to the casual glance they seem far better fitted for title-pages or bookplates or even for textiles than for execution in any of the heavier materials in which the interior decorator works. But over two of these fragile and dainty examples of the engraver's art there are hung in the Museum galleries great panels of heavy wood upon which the designs have been carved out as wall decorations, one in paint and the other in carved oak. The carved panel is particularly enlightening when compared with the engraving because few woods are heavier or coarser in grain than oak, and yet it has been used to perfection as the medium in which the peculiarly light and graceful lines of the etching should be given permanence. Throughout the panel the design has been given more swing and its elements thrust a little wider apart than in the print, so that its heavier lines could get the same amount of free play. Just as the engraving is a masterpiece of refinement and minuteness, so is the carving one of the most beautiful among the many beautiful pieces of carved wood in the great Morgan Collection. It would be difficult to find a more perfect example of the marvelous manner in which the master craftsmen of old France utilized the wealth of design that the artists and draughtsmen produced for their benefit.

In a case in the middle of the opposite wall of the same gallery are shown ormolu mounts for furniture, among which is a series of swags and garlands which obviously were inspired by these same dainty etchings of flowers—the metal craftsman working his bronze as easily and surely as the painter or wood-carver manipulated his own materials.

In the gallery containing the earlier works, there is a splendid showing of Renaissance design of this same abstract nature. A single frame, for instance, contains a reproduction of a print by Aldegrever, the original of which is in a neighboring frame, and beside it, reduced to the same scale, photographic reproductions of a carved stone panel, a glazed and colored stove tile and a beer mug, all bearing the

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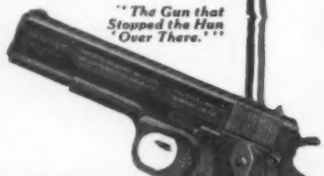

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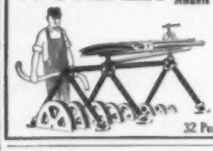

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same design as that contained in the little print.

As interesting as anything in the whole exhibition are the two large floor cases containing rare old patterns for textile workers, which are accompanied in each case by a piece of lace or drawnwork or embroidery, often made slavishly from the little black and white woodcut design, and in other instances, showing how the needleworker varied or simplified the pattern set for her by the woodcutter. Many of these needlework designs were also utilized in their time by wood inlay or intarsia workers, and by wood and stone carvers in the laying out of work intended for panels and friezes in rooms and on large pieces of furniture, and by inlayers and metal workers for borders around small boxes and other suitable objects.

Particularly important is the series of designs for cups and goblets in fine metal and crystal, for in them can be seen the same elements utilized in embroidery, in carvings, and in furniture by the makers of such things in the great days of the Renaissance. There are a large number of most surprising flower and leaf designs which found their way into the hands of tapestry makers, silversmiths, and the men who carved crockets and ends of chair handles. Rarely, if ever before in this country, has there been an exhibition containing more beautiful and exquisite designs than this one at the Metropolitan Museum of Art, and certainly there has never been one like this in which the multifarious uses to which designs of the greatest masters were put in practice have been illustrated by actual juxtaposition of design and related work of the craftsman. To the designers and craftsmen of today this exhibition offers an opportunity such as has never before been given them to see the actual way in which their predecessors availed themselves of the wonderful material to be found in old books and prints and how they turned that wealth of design to their own purposes, especially to the long-headed business man, be he producer or distributor, who is able to gage the direction of industrial art development in this great country, such an exhibition is a source of much information and an index of unlimited possibilities for the improvement of current products. Design has always been a selling factor, for design is bound to remain in all types of home furnishings and other industrial art objects the primary factor of quality.

Airplane Researches of Value in Other Fields

THE war has placed an opportunity in the hands of furniture and panel manufacturers to benefit by the increased knowledge of the peculiarities and characteristics of wood and glue.

Under the stress of war and the necessity of furnishing aircraft to the fighting front in large numbers and a short time, it was found necessary to supplement the information available on wood and glue by extensive additional research work on these two important construction materials It was found in many instances that factories taking government contracts for aircraft and wagon work had in their desire to help neglected to go into the situation thoroughly and found themselves unable to produce on schedule. The rigid government inspection showed them that their equipment was inadequate to meet the special demands placed upon it, and their knowledge of the peculiarities of the material was not sufficiently exact.

Many varied difficulties were encountered. Vehicle manufacturers had trouble drying stock. Lumber for wagons to be used in the hot, sandy sections required more thorough drying treatment than lumber for wagons to be used in more moist districts, and it was necessary to dry heavy stock quickly. Propeller manufacturers found that making propellers involved a great many more variables than the mere gluing of laminations and shaping the block—internal stresses occurred that caused warping and open joints in seemingly perfect blocks. Though they had been using glues for many years they soon discovered that there was a wide difference between high grade laminated work and the class of work ordinarily accepted as commercial standard. It is not surprising that the panel manufacturers making aircraft plywood for the various governments had some little difficulty at first in meeting aircraft specifications.

While waterproof glues have been in existence for some years, they were not well known and little information was at hand as to the correct procedure for their successful use. During the war the Forest Products Laboratory of the U. S. Forest Service at Madison, Wis., has been working on problems that seemed to give trouble to the plants engaged on war contracts. Much help has been given manufacturers and a large staff of specialists has been engaged in obtaining information and developing new ideas in the uses of glues and wood.

It must not be inferred that absolute information is at hand concerning all phases of the uses of woods, and that the laboratory will be at once a panacea for all ills. Even though much has been learned, there is still much to be done. It is merely pointed out that the Government maintains under jurisdiction of the Forest Service an institution equipped to handle many of the difficult problems continually arising in the manufacture of furniture and panels.

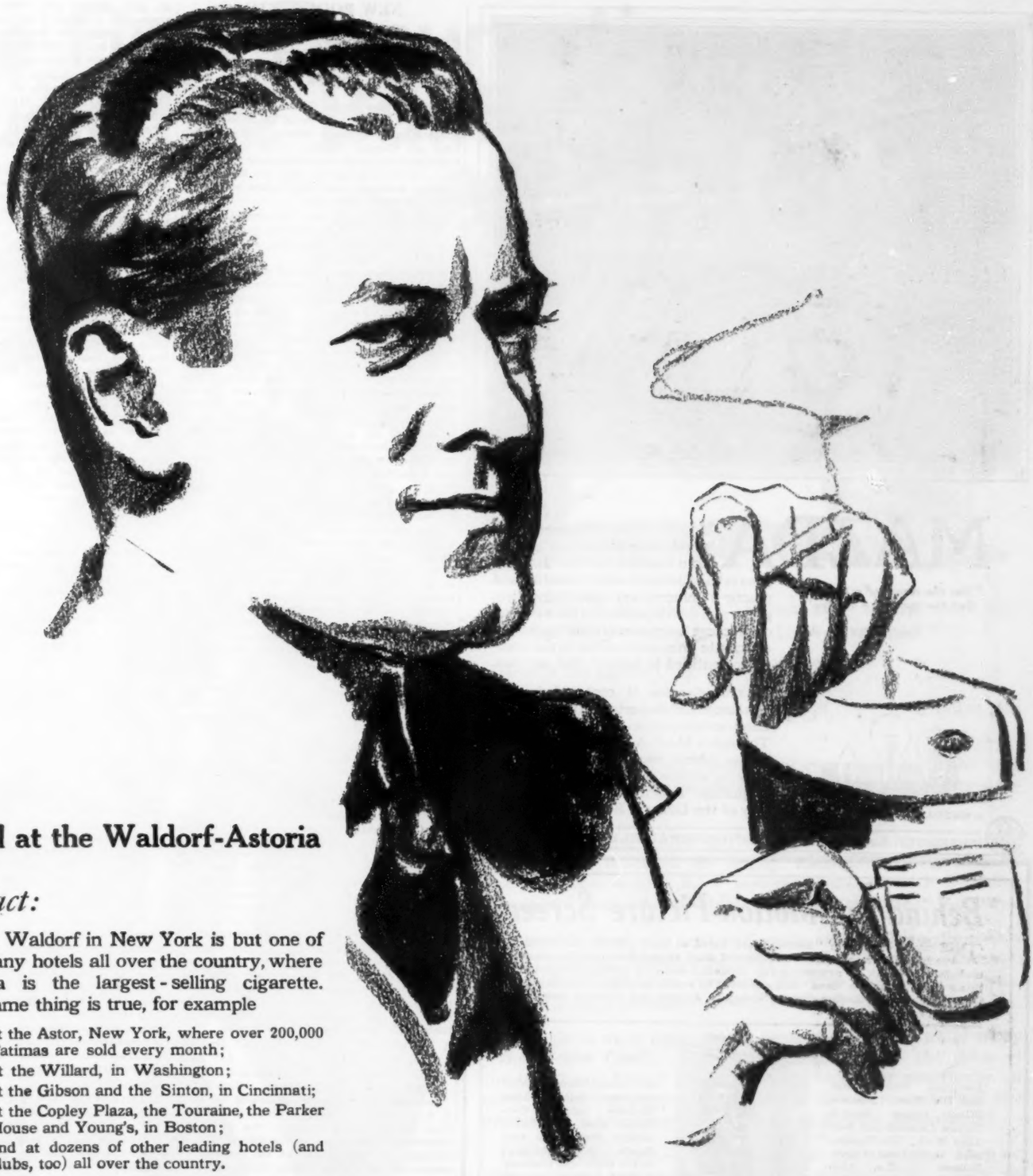
"Pertinax" as a Substitute for Mica and Other Things

THE compressed paper product, called "Pertinax" is a useful substitute for mica for electrical purposes, according to a report in a German paper. The particularly high insulating qualities of mica are connected with its peculiar structure in layers, and this structure has been successfully imitated in "Pertinax." The material is particularly able to withstand pressure (for instance, in the shape of tubes, it is far superior to lead tubes as regards its resistance to internal pressure), and it can easily be worked similarly to wood, that is to say, it can be turned, stamped, and drilled. "Pertinax" approaches mica very closely in its electrical properties. Its puncture voltage is about 25,000 volts. The material is not affected by hot oils, and only begins to be destroyed at 200 degrees centigrade. The tensile strength is 6.35 tons square inches, and is therefore, nearly as high as that of the best Australian wood.

The word is coined from the Latin. The pipes are made by impregnating sheets of paper with synthetic resin, and rolling them around a mandrel of the desired dimensions until the proper thickness is secured. Heat and pressure are maintained meanwhile until a hard product is obtained. Formerly natural resins were used, but the introduction of the synthetic variety has raised the temperature of softening to above 180 degrees centigrade.

Difference of opinion seems to exist as to the effects of water upon the material. Though one writer claims that it i insoluble and water-proof, another states: "Their absorption of water makes their use inadvisable for that liquid, but they gave excellent results when used to carry oil, a fact which is explained by the well-known resistance of synthetic resins to oils." There is no record of their being used successfully for water pipes, though they were practical for carrying gas and oil.

Experiments showed that pertinax pipes could bear interior pressure three to four times as great as that of lead pipes, while the weight is less than a ninth that of lead. A series of tests made at the Royal Institute for testing materials showed that they are not fitted for construction uses, since, while their resistance to tension is sufficient, their resistance to compression and their elasticity are both too feeble. The tensile strength is 14,250 pounds per square inch. It is able to be worked similarly to wood being turned, stamped, sawed out and drilled.



. . . and at the Waldorf-Astoria

A fact:

The Waldorf in New York is but one of the many hotels all over the country, where Fatima is the largest-selling cigarette. The same thing is true, for example

—at the Astor, New York, where over 200,000 Fatimas are sold every month;
—at the Willard, in Washington;
—at the Gibson and the Sinton, in Cincinnati;
—at the Copley Plaza, the Touraine, the Parker House and Young's, in Boston;
—and at dozens of other leading hotels (and clubs, too) all over the country.

Liggett & Myers Tobacco Co.

FATIMA

A Sensible Cigarette

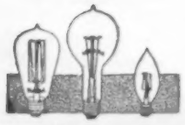
NOTE—At such places as these, low price doesn't count. Fatimas lead in sales, not because of their low price, but because men PREFER them to higher-priced cigarettes. They prefer Fatima's taste; and they find that Fatimas treat them right.

MAZDA

"Not the name of a thing, but the mark of a service"

MAZDA is the trademark of a world-wide service to certain lamp manufacturers. Its purpose is to collect and select scientific and practical information concerning progress and developments in the art of incandescent lamp manufacturing and to distribute this information to the companies entitled to receive this service.

MAZDA Service is centered in the Research Laboratories of the General Electric Company at Schenectady, N.Y. The mark MAZDA can appear only on lamps which meet the standards of MAZDA service. It is thus an assurance of quality. This trademark is the property of the General Electric Company.



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Behind the Motion-Picture Screen

THE mysteries of the "Movies" are bared at last! It has remained for Austin C. Lescarboura of the Editorial Staff of the Scientific American to undertake the task of answering the thousand-and-one questions constantly being asked by screen "fans" and aspirants to screen careers, in his book entitled, "Behind the Motion-Picture Screen." Among the subjects covered in his work are—

Scenarios. The Director and His Work. Motion-Picture Acting. Motion Picture Cameras and How They Work. The Cameraman. In the Land of Make Believe Studios. Mob Stuff. Tricks of the Screen. Laboratory Work. Pictures

in Natural Colors. Microscopic Subjects. Talking Pictures. Animated Cartoons and Sculpture. Motion Pictures in Odd Fields. Motion Pictures in the Home and Business. Present Status and the Future of Motion Pictures.

This book has been written in a simple, interesting, and instructive style. It is not technical; yet it covers all phases of the screen art in an accurate and unbiased manner. Pictures? Certainly; this book is the best illustrated book on the subject—over 300 pictures. Indeed, every right-hand page is a picture page; every left hand a corresponding text page. It is something entirely new in book making. "Behind the Motion-Picture Screen" contains 426 pages and over 300 illustrations, printed on the finest coated paper and bound in an attractive cloth cover measuring 6¼ by 9¼ inches. **Price, $3.50 net; Postage Extra.**

Special folder containing full description and sample pages, sent on request.

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NEW BOOKS, ETC.

KUTENAI TALES. By Franz Boas. Together with texts collected by Alexander Francis Chamberlain. Washington: Government Printing Office, 1918. 8vo.; 387 pp.

The folk tales of the Kutenai disclose an intimate relationship to those of the tribes of the plateaus and the eastern plains. Many of these tales are brought together here, the original language being paralleled, and in some cases interlined, by the translation; they are followed by valuable abstracts and comparative notes, and by an extensive vocabulary.

THE BUSINESS OF THE HOUSEHOLD. By C. W. Taber. Philadelphia and London: J. B. Lippincott Company, 1918. 8vo.; 438 pp.; illustrated.

With the assistance of several professional and technical experts, the author presents a detailed study of household business and finance; as in all business, there are complex factors which make efficiency dependent upon a firm grasp of fundamental principles, an appreciation of what "leakage" means, and a whole-hearted devotion to the work. All these things are put plainly before the student, and the book makes a good text for high school and college as well as a practical manual for the housekeeper; the final chapters deal with the legal and business status of the family. In its practical teachings and suggestions the work well upholds the standard set by the Home Manuals series, in which direct helpfulness is the chief aim.

THE BOOK OF PHILADELPHIA. By Robert Shackleton. Philadelphia: The Penn Publishing Company, 1918. 8vo.; 413 pp.; photographs and drawings.

The author who so charmingly ciceroned us through New York now transports us to the "City of Unbrotherly Indifference," a city with an individuality all its own, with a rich historical endowment, snug-hidden old churches, and ancient sections teeming with memories. Mr. Shackleton, chatting blithely, leads us through streets and byways, tells us how the wise Franklin here got the worst of a real estate deal, and discourses of artists, actors and authors, public buildings, clubs and homes. Reading, we come to know Philadelphia very well, from its exasperating perfections to its lovable foibles; more, we actually see it, for the plentiful illustrations are faithful and artistic reproductions.

FROM NEBULA TO NEBULA. Or the Dynamics of the Heavens. By George Henry Lepper. 1510 Berger Building, Pittsburgh: George H. Lepper, 1919. 8vo.; 401 pp.; illustrated.

The author is a scientific insurgent who brings to his task more thorough knowledge and better powers of expression than is usually found in similar attempts at cosmological reconstruction. Recent theories are presented and their weak spots are vigorously attacked. By an expansion of the principle of gravitation, he arrives at an ingeniously simple theory of planetary motion which he believes satisfactorily solves most questions and reconciles seeming contradictions. His basic idea is that of an "hitherto neglected factor, the prime stellar resultant," which marks the path of the solar system's northward fall; from this he concludes that the sun and planets in their velocities, distances and periodic times conform to the laws of balanced weights revolving horizontally and falling at the same time.

A TEXT-BOOK OF AERONAUTICS. By Herman Shaw, B.Sc., A.R.C.S., A.F.Ae.S. Philadelphia: J. B. Lippincott Company, 1919. 8vo.; 260 pp.; illustrated.

Lectures delivered before officers of the R. N. A. S. and R. A. F. are here recast into suitable form for the use of students; the elementary mechanics of the subject are developed, with the influence of various factors on construction; engines and air screws, airplane design and types, instruments and their uses, and rigging, testing and maintenance are concisely dealt with. Other chapters take up balloons and airships, navigation, meteorology, bomb-dropping, wireless, and aerial photography. There is a profusion of diagrams and figures, and several large, folding inserts demonstrate engine design and meteorological map-reading.

HOME AND COMMUNITY HYGIENE. A Text-Book of Personal and Public Health. By Jean Broadhurst, Ph.D. Philadelphia and London: J. B. Lippincott Company, 1918. 8vo.; 428 pp.; 118 illustrations

Without health, the whole fabric of civilization must crumble. It is not enough that curative medicine advance in strides; the cooperation of the individual and the community must be secured. Miss Broadhurst contributes an important work to the Home Manuals series in these papers, that make interesting to young people, teachers, nurses and mothers such topics as micro-organisms, the human mechanism, food, air, and sewage and refuse disposal. In illuminating chapters it discusses the transfer of disease, disinfection, the home, summer camp, and school, and mental hygiene. It is a readable, enjoyable book of facts and methods.

ASPHALTS AND ALLIED SUBSTANCES. Their Occurrence, Modes of Production, Uses in the Arts and Methods of Testing. By Herbert Abraham, B.S. of Chemistry. New York: D. Van Nostrand Company, 1918. 8vo.; 606 pp.; 208 illustrations.

A great deal of valuable information is offered by this volume to all who are concerned in the manufacture, sale or application of bituminous products. Introductory material includes a historical review, and the chemistry, geology and origin of bituminous substances. Part II deals with semi-solid and solid native substances; Part III with tars and pitches; and Part IV with manufactured products and their uses—paving materials, roofing, flooring, and insulation, etc., and paints, varnishes and cements; the final section is devoted to methods of testing. It will be seen that the work is of wide appeal; among those especially benefitting by its guidance being the works chemist, the refinery or factory superintendent, the salesman, the engineer, the contractor and the architect.

THE WAR GARDEN VICTORIOUS. By Charles Lathrop Pack. Philadelphia: J. B. Lippincott Company. Illustrated.

This attractive book celebrates an exploit of the great war—a victory won on United States soil; the soil was that of city backyards, factory grounds, and other unpromising sites; the conquering army, the busy men, women and children of our land. Where ashes and weeds once reigned, bountiful crops sprung up—and in many a heart sprang up a new love of the soil. No great movement is accomplished without organization; behind this achievement stood the National War Garden Commission. It is the President of that Commission who tells this story of the inception and development of the home and community garden movement; and the story he tells and the pictures he exhibits are for free presentation to those who forwarded the great economic work. All who can gain access to the volume will be well rewarded.

ENGINEER DRAUGHTSMEN'S WORK. By a Practical Draughtsman. New York: Isaac Pitman and Sons, 1918. 12mo.; 96 pp.; illustrated.

These hints are for those aspiring students in schools, colleges and shops, whose eyes turn toward the draughting-room. Instruments, appliances, methods and practice are succinctly made known, the record and storage of finished drawings and prints are explained, and there is a chapter on the planimeter and its use. Plentiful figures clinch the teachings of the text.

VALVES AND VALVE GEARS. Vol. II.—Gasoline, Gas and Oil Engines. By Franklin De Ronde Furman, M.E. New York: John Wiley and Sons, Inc. 8vo.; 444 pp.; illustrated.

The first volume of this work dealt with steam engines and turbines; the second takes up the internal combustion engine. This separation of the two branches of the subject facilitates the study of particular cases without the confusion caused by interloping material. The seven fundamental valve forms and six fundamental mechanisms that account for all valves and gears in common use are so presented that the whole subject is simplified, and the valve equipment of all prime movers quickly made understandable. The material is carefully arranged and very thoroughly illustrated.

MANAGEMENT AND EXECUTIVE CONTROL. New York and Chicago: A. W. Shaw Company, 1919. 8vo.; 328 pp.; illustrations and folding inserts.

Here, a bank that has become a power in the community; there, one to which the term "progress" would be inapplicable. In "Management and Executive Control" the causes operating toward success or failure are found in a careful analysis of conditions; the essentials of good management are categorically brought out, important problems are stated and solved, better trust and savings methods are inculcated, and significant profit factors are closely considered. The division and lessening of labor, how tellers can build business, speeding up department work, hiring and training of employees, women in banking—these and many other topics are practically handled.

AIDS TO IDENTIFICATION OF GEOLOGICAL FORMS. By J. A. Udden. Austin, Texas: The University of Texas. 16mo.; 69 pp.

This compact little manual places in the hands of drillers such information as will help them toward the correct identification of the materials encountered in drilling for oil, gas, and water, with particular reference to Texas formations; its chief aim is greater accuracy for the "log."

The First Pneumatic Truck Tire Built

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It was in 1911—at the Detroit factory of the United States Tire Company.

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Later this truck was sent to Canada and put into the service of the Canadian Consolidated Rubber Co., at Kitchener, Ontario. It is still in operation, running between neighboring towns, carrying a daily *average* of twenty tons of freight.

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